

ANNUAL REPORT

CIEMAT

(Energy, Environmental and Technological Research Center)

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CIEMAT, 1991.

Translated for

U.S. Department of Energy  
Washington, D.C.

Translated by

SCITRAN COMPANY  
1482 East Valley Road  
Santa Barbara, California 93108  
(805)969-2413  
FAX (805)969-3439

ANNUAL REPORT

1991

CIEMAT

ENERGY, ENVIRONMENTAL, AND TECHNOLOGICAL  
RESEARCH CENTER

GENERAL SECRETARIAT OF ENERGY AND MINERAL WASTE  
MINISTRY OF INDUSTRY, COMMERCE, AND TOURISM

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## PRESENTATION

This year, as all previous years, CIEMAT presents its Annual Report. In it we describe the activities, which reflect the most significant work undertaken during 1991. Through its flexible strategy, the activities correspond to the established priorities in the energy and environmental areas of I+D. This is in accordance with the instrumental function of CIEMAT in its roles as an organ of the Ministry of Commerce and Tourism, which was appointed as such by the General Secretariat of Energy and Mineral Resources. The operating plan and degree of maturity, achieved during execution of the programs, make the Center a representative of the National and International Institutions, who are interested in energy and environmental research. It also contributes with its research results to resolving the growing needs of our country in this area.

These are obligatory guidelines in the selection of our objectives and allow us to react -- quickly and with flexibility -- to the frequent changes, which characterize the evolution of the industrialized societies.

RAMON PEREZ SIMARRO  
Secretary General of Energy  
and Mineral Resources  
President of CIEMAT

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<sup>1</sup> Numbers in margins indicate foreign pagination. Commas in numbers indicate decimals.



CIEMAT's activities, during 1992, correspond to the overall programs in the specialized areas, in such a way that the completed projects represent a continuous evolution. We pay special attention to the needs and problem of our associates, with whom we maintain very good relations. A true test of this is the increasing number of agreements and contracts for projects and diverse technical activities of assistance and help, from National and International enterprises and entities.

Our activities in 1991 involve the following:

In the area of nuclear fission technology, the activities were focused on research on operations, in which the essential subjects are related to the life span increase and safety of the plants. We also developed projects, the results of which contribute to technical solutions, thus guaranteeing stable and safe waste storage.

The actions in the fusion program correspond to the planning of the established 7 year schedule, with a budget of more than 11,000,000,000 pesos. Its objective is the construction of an experimental machine, capable of providing useful results to the European group. It is also providing training to a large, and highly specialized, technical group in our country.

In the area of renewable energy the projects' objectives respond to the challenge of incorporating these technologies in the production of electric energy. This is done through the construction of special systems with great potential, which are reliable and sensitive to the cost of construction and operation. We are also undertaking research and

feasibility studies of solar technologies, with the purpose of eliminating the toxic waste. The preliminary results are promising.

The fossil fuels, especially coal, constitute a new area of action. Beginning with a profound knowledge of the fluidized bed technology, we participate in growing projects with the enterprises of the sector, and expect to consolidate these in the future. These are going in two directions: developing technologies such as production systems and demonstrating their environmental capabilities, in which the energy aspect is an important factor.

This technology is incorporated in the Environmental Technology program, thus enriching the traditional lines of action of the Center in the environmental area, which supports the projects related to environmental impact and nuclear technology. In the conventional environmental area, we proceed with activities for characterizing the behavior of the atmospheric contaminants in the basin areas and the transport phenomena of the same.

Finally, I do not wish to conclude this presentation, without mentioning other projects, such as: High Energy Physics research, Metrology, development of advanced sensors etc. and other activities as important as the specialized formation, information support, and engineering, the achievements of which are detailed in the Report, and all actions of an organization with a professional team, which intends to, on day to day basis, complete the objectives of serving society under the direction of the Ministry of Industry, Commerce and Tourism.

JOSE ANGEL AZUARA SOLIS

Vice President and General Director of CIEMAT.

## ORGANIZATION

## ORGANIZATION

CIEMAT (Energy, Environment and Technology Research Center) is a public organization for technological research and development. Its activities are directed by the search for solutions to improve the utilization of resources and the existing energy generating systems. We also develop research programs, which permit the use of alternative energy, paying attention, in all cases, to the problems of environmental impact (brought upon by some of these activities.) We tackle other industrial activities, which are related to the safety of the industrial installations, and to the development of advanced technologies.

Administratively speaking, CIEMAT is an autonomous Organ of state administration, appointed by the Industry of Commerce and Tourism, through the General Secretariat of Energy and Mineral Resources, which is appointed in law 13/1986, of April 14 for encouragement and general coordination of scientific

and technical research by law 25/1964 of April 29, regarding nuclear energy, and also other documents per law of December 26, 1958, which regulates the autonomous state entities. These regulations shape the Center as a direct public entity with its own personal jurisdiction.

CIEMAT has centers in Moncloa, Madrid (the headquarters), where the most important installations are located; the center in Lubia, Soria, which is dedicated to programs of energy evaluation of the forest resources; and the solar installation in Almeria, Tabernas, which is an installation of great interest to the Europeans. It is a world class, most advanced experimentation center, dedicated to the applications of solar energy.

CIEMAT consists of four institutes, according to their specific activities: renewable energy, environmental, nuclear energy and basic research. The Directorate of Technology provides support to all institutes. It has the necessary infrastructure for completing its work. In addition, the Institute for Energy Studies is responsible for the internal and external formation, as related to the activities and goals of CIEMAT. There are also three Directorates for general assistance, and a General Secretariat for technical coordination.

CIEMAT is a part of the society of public enterprises: the National Enterprise of Uranium, S.A. (ENUSA), whose activities are related to the first phase of the nuclear combustion process; the National Enterprise for Radioactive Waste, S.A (ENRESA), which is in charge of total management of radioactive waste.

BOARD OF DIRECTORS OF CIEMAT

President

- Ramon Perez Simarro

Vice-president

- Jose Angel Azuara Solis  
(General director)

Consultants

Guillermo Leira Rey  
Minister of Defense

Pilar Brabo Castells  
Minister of Interior

Enrique Clemente Cubillas  
Minister of Public Works and Urban Development  
(until August 1991)

Regina Revilla Pedreira  
Minister of Industry, Commerce and Tourism  
(until May 1991)

Carmen de Andres Conde  
Minister of Industry, Commerce and Tourism  
(from June 1991)

Miguel Arias Estevez  
Minister of Foreign Affairs  
(until May 1991)

Delfin Colome Pujol  
Minister of Foreign Affairs  
(from June 1991)

Federico Montero Hita  
Minister of Economy and Housing

Ismael Diaz Yubero  
Minister of Health and Consumption  
(until March 1991)

Juan Jose Franciso Toledo  
Minister of Health and Consumption  
(from June 1991)

Luisa Huidobro y Arreba  
Minister of Industry, Commerce and Tourism

Luis Oro Giral  
Minister of Education and Science

Free Lance Consultants

Juan Kindelan Gomez de Bonila  
ENRESA

Jose Manual Jimenez Arana  
ENUSA  
(until November 1991)

Alfredo Llorente Legaz  
ENUSA  
(from November 1991)

Feliciano Fuster Jaume  
ENDESA

Adolfo Martinez Gimeno

Rafael Martin Moyano  
OCIDE

Fabio Sarmiento Almeida  
Counsel of Nuclear Safety

Francisco Serrano Martinez  
IDAE

Secretary

Luis Iglesia Martin  
General Technical Secretary of the Center

CIEMAT  
ENERGY, ENVIRONMENT AND  
TECHNOLOGY RESEARCH CENTER  
GENERAL SECRETARIAT OF ENERGY  
AND MINERAL RESOURCES  
MINISTRY OF INDUSTRY  
COMMERCE AND TOURISM



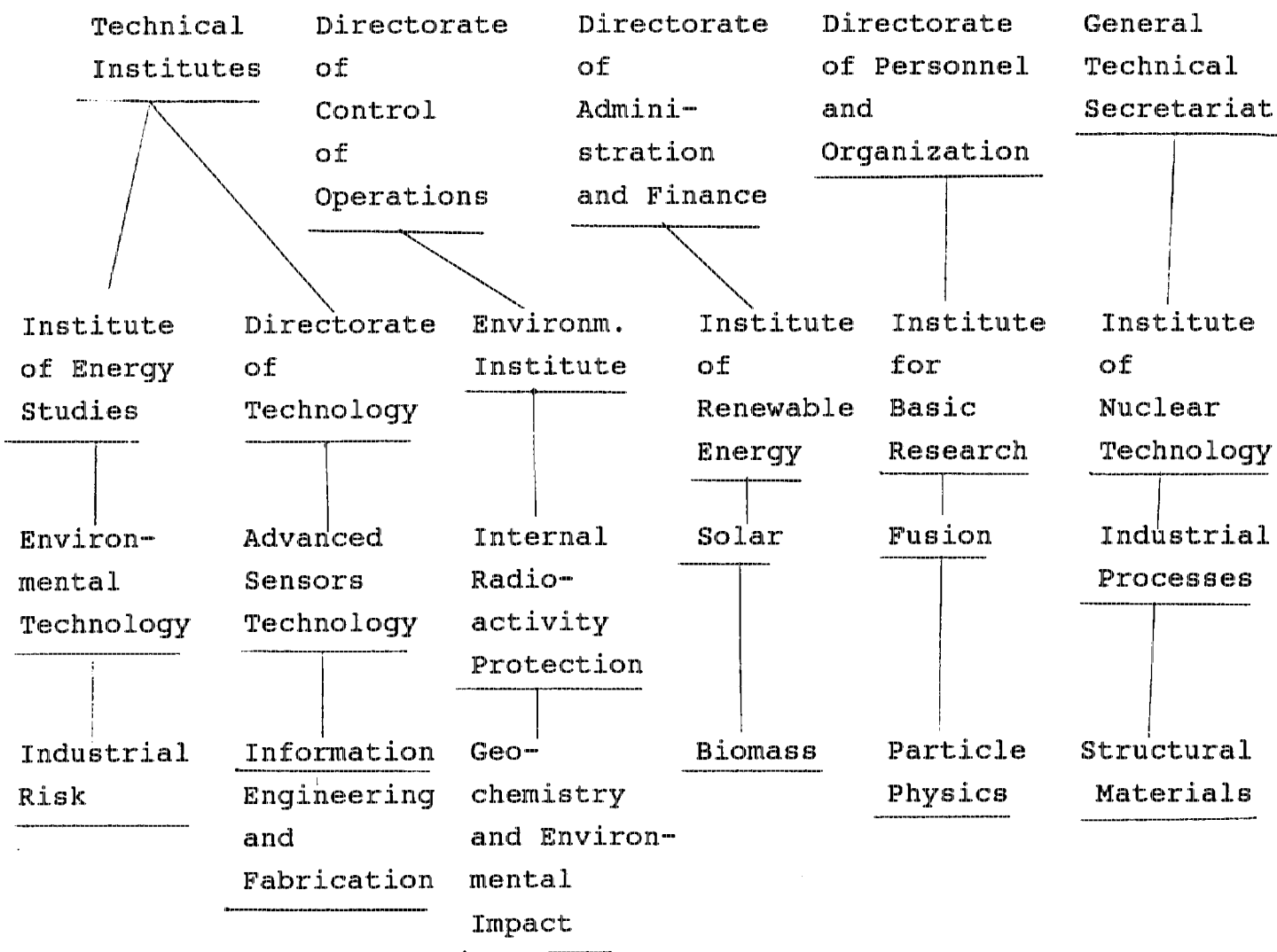


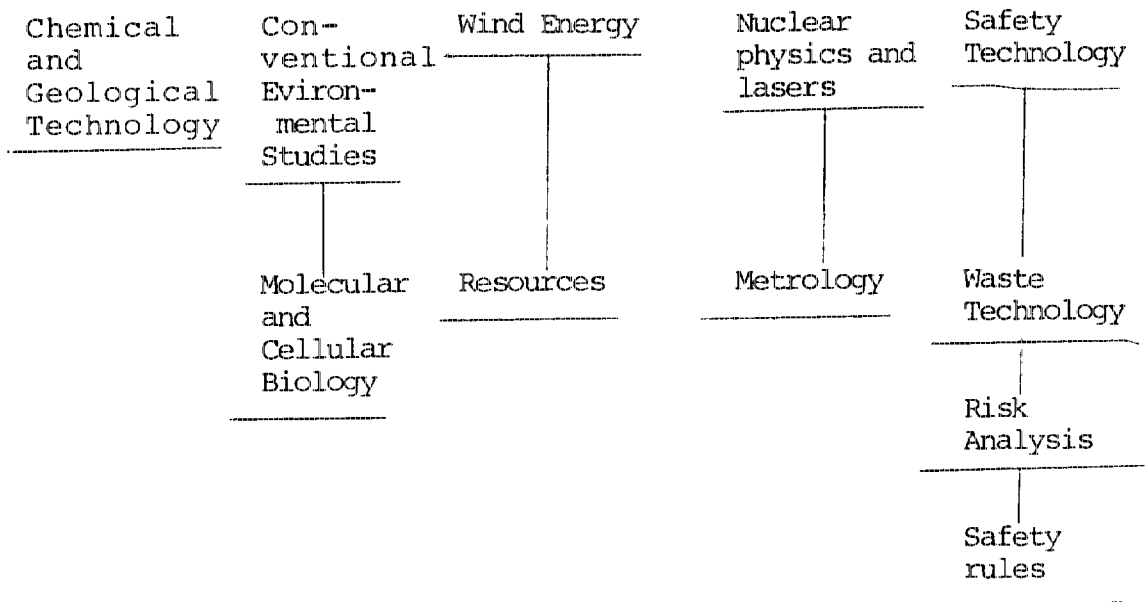
PRESIDENCY

GENERAL SECRETARIAT OF ENERGY  
AND MINERAL RESOURCES

VICE-PRESIDENCY AND  
GENERAL DIRECTORATE

DIRECTORATES FOR  
GENERAL SUPPORT



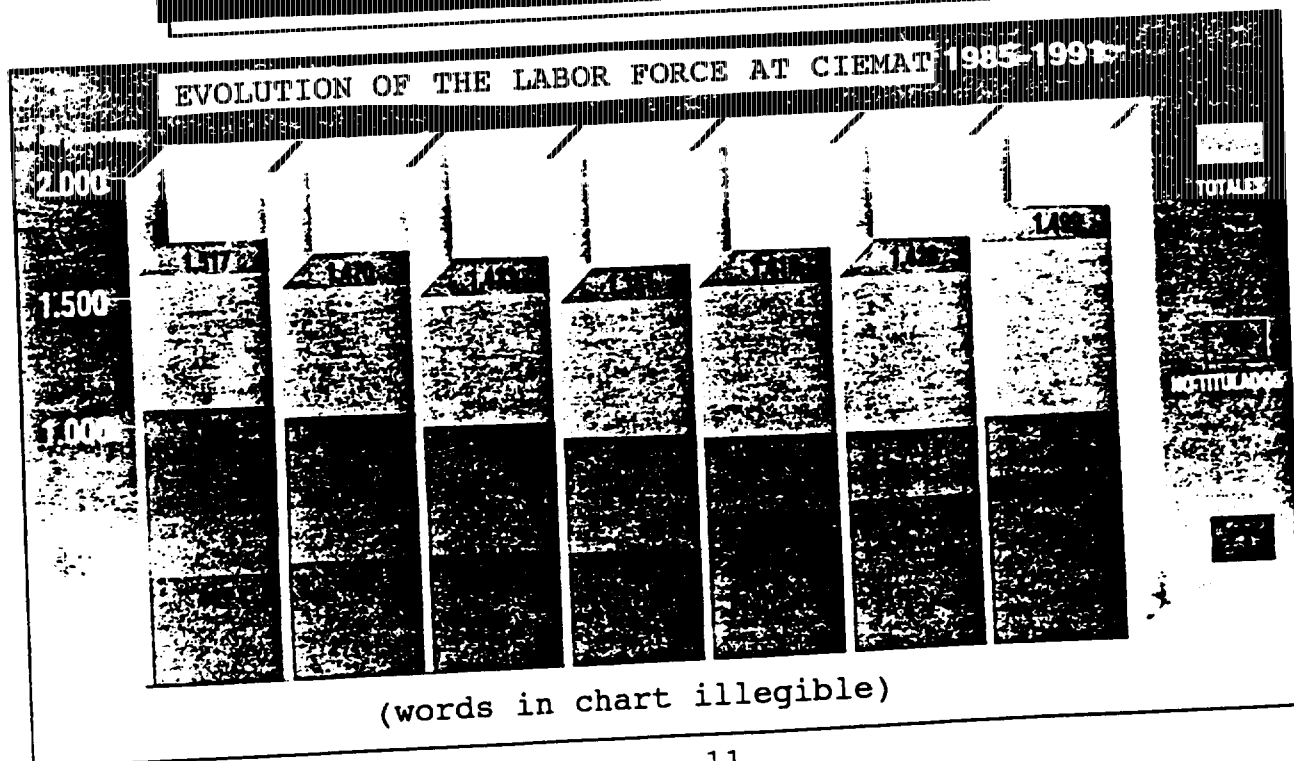
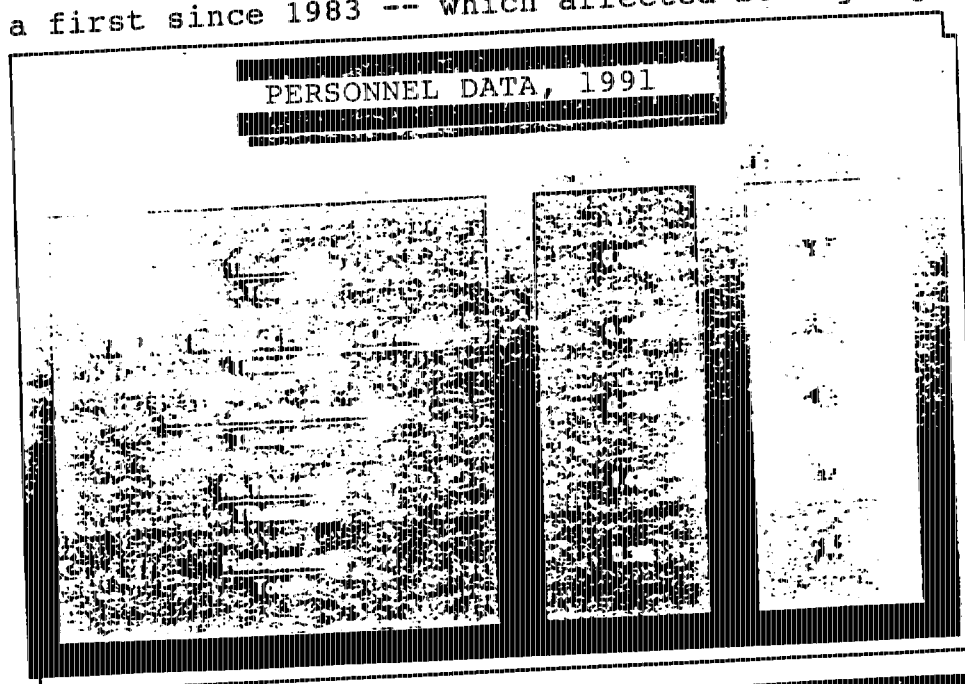


## HUMAN RESOURCES



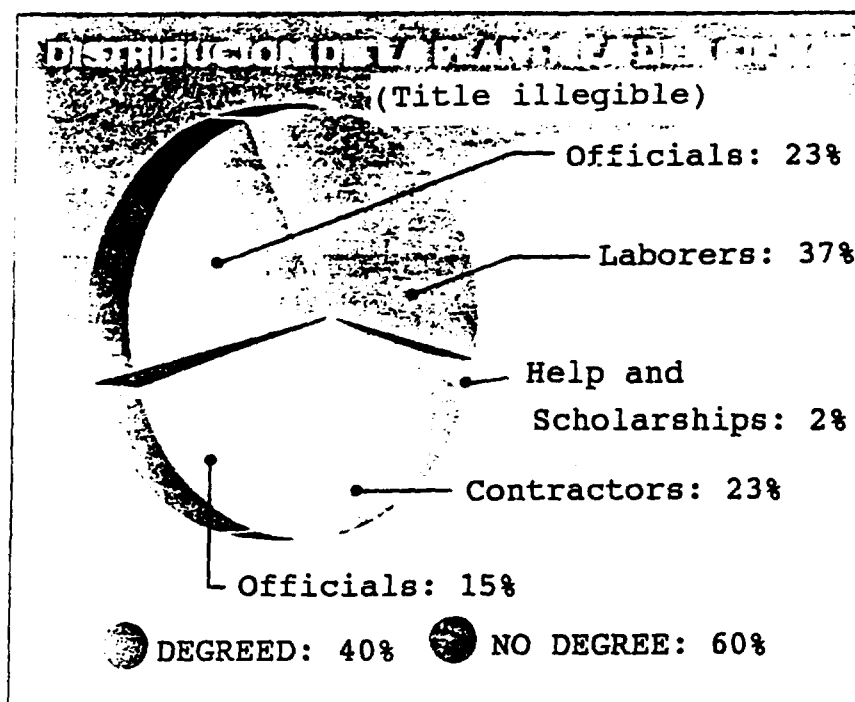
# HUMAN RESOURCES

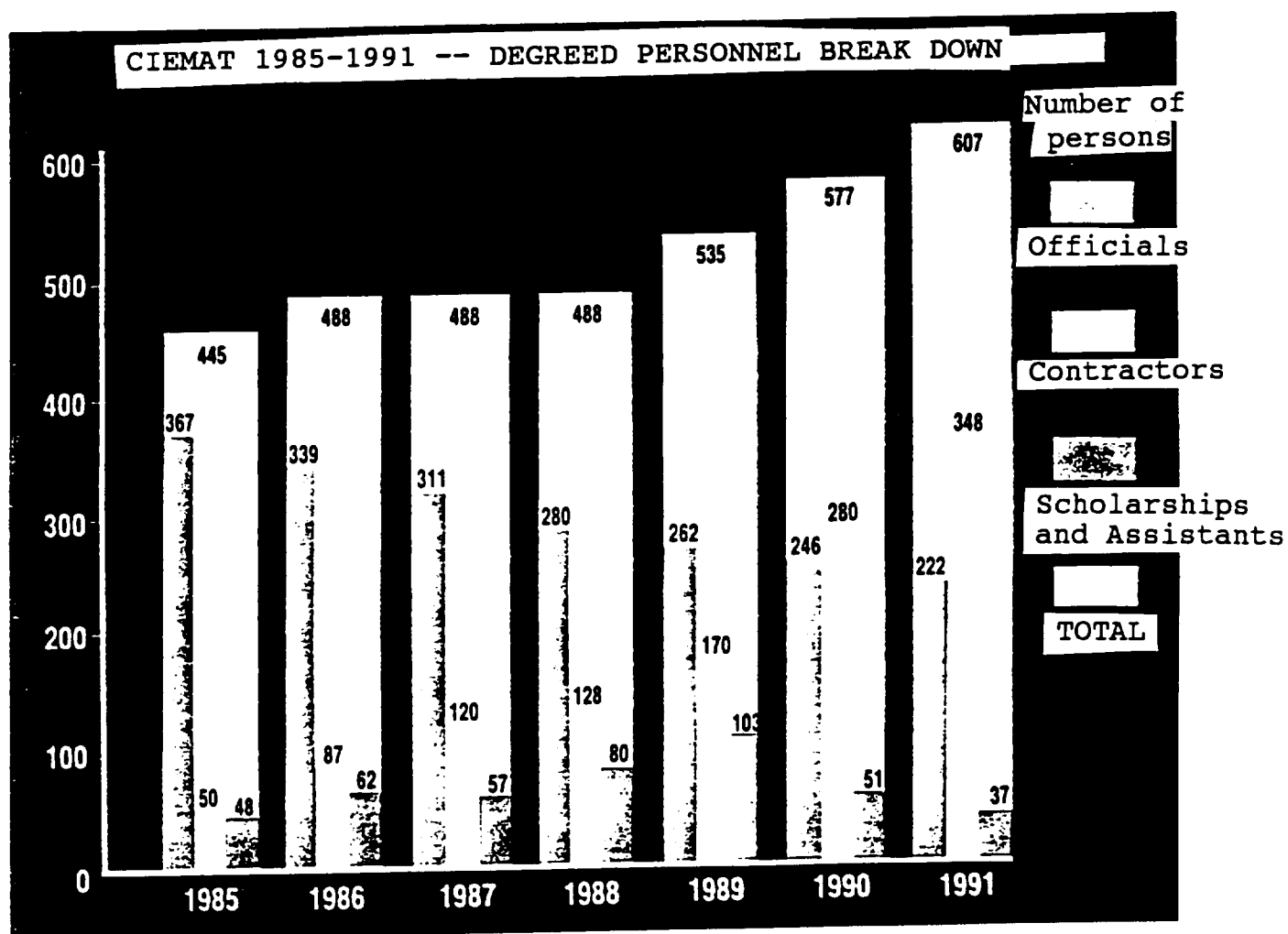
In 1991 the human resources policy, which was initiated in 1983, was consolidated and stabilized in terms of the ratio of degreed and non-degreed personnel. In 1990 the ratio between the teams of degreed and no-degree personnel was 2:3. It was maintained in 1991, regardless of the increase -- a first since 1983 -- which affected both groups.



The more important actions, completed during 1991 can be summed up as follow:

- Signing of the Group Contract for the auxiliary labor personnel, which represents an important organizational change. It replaces the old professional classification.
- Approval, by the executive committee, of the CIR of the PRT for personnel function, thus correcting the existing situation, which started in 1988.
- The completion of "contest-opposition" tests, which filled 23 positions of officials of the Technical Research Specialists type, and 12 positions of Technical Research Auxiliaries.
- Selection and incorporation in CIEMAT's ranks of 62 professionals, who will be integrated in the process of forming new researchers.
- Signing of a new Contract with the community of Madrid for hiring of 25 young workers. They will be given title of Professional 2nd class, after finishing their studies.
- We continued the process of converting scholarship recipients and research assistants into contract status.







## ECONOMIC AND FINANCIAL RESOURCES

## ECONOMIC AND FINANCIAL RESOURCES

In 1991 the income, in disposal at the Center, was received as follow:

State Transfers.....	6,298
Financial Assets.....	20
I+D Activities.....	2,402
ENUSA and ENRESA Dividends.....	409
Other Income.....	35
Previous Obligations and Rights.....	80
Regulations.....	-11
 TOTAL.....	<hr/> 9,233

Although the income from the State has been increasing, but when expressing the numbers and actual pesos, in reality the income has been leveled. The financing of activities, developed at the Center has been possible because of the progressive increase of income from services (commercial operations) and from I+D research and development activities.

53% of all costs are destined for personnel expenses and 21% for investments and 15% for current goods and services (Chapter 2).

8% of the budget (transfer of capital, Chapter 7), is dedicated to work on important International projects, in which CIEMAT participates actively: the fusion program of EURATOM, the Solar Installation at Almeria and the experiments L3 and UAI of CERN.

For this end, and keeping in mind that 42% of all costs cover expenses for goods and services in particular projects, we can calculate that 71% of all costs are directed towards activities in these projects: investments, agreements for technical collaboration, etc.

BUDGET EXPENSES OF THE CENTER  
(1994-1991) MPTA)

CHAPTER	1984				1985				1986				1987			
	P.I.	P.D.	O.B.	%(1)	P.I.	P.D.	O.B.	%(1)	P.I.	P.D.	O.B.	%(1)	P.I.	P.D.	O.B.	%(1)
1. Personnel	3.176	3.186	2.758	87	3.314	3.547	3.130	88	3.793	3.791	3.119	82	3.957	3.957	3.397	86
2. Goods and Services	641	722	618	86	718	740	724	98	707	817	772	94	764	947	911	96
4. Current Transfers	259	275	256	93	266	323	277	86	244	267	256	96	228	228	221	97
6. Transfers of Capital	1.176	1.294	723	56	991	1.638	1.398	85	1.119	2.087	1.707	82	1.313	1.351	1.292	96
7. Financial Assets	0	0	0	-	0	0	0	-	104	84	82	100	136	298	282	95
8. Active Finances	0	11	11	100	9	15	15	100	9	22	22	100	8	9	9	100
TOTALS	5.252	5.488	4.366	80	5.298	6.263	5.544	89	5.976	7.068	5.958	84	6.406	6.790	6.112	90

CHAPTER	1988				1989				1990				1991**			
	P.I.	P.D.	O.B.	%(1)	P.I.	P.D.	O.B.	%(1)	P.I.	P.D.	O.B.	%(1)	P.I.	P.D.	O.B.	%(1)
1. Personnel	3.848	3.848	3.639	95	3.873	3.905	3.659	94	4.064	4.077	3.871	95	4.267	4.280	4.107	96
2. Goods and Services	834	1.073	1.058	99	914	1.153	1.131	98	972	1.189	1.154	97	1.003	1.133	1.120	99
3. Financial Expenses									10	10	0	0	10	10	0	0
4. Current Transfers	228	269	249	93	256	256	226	88	257	257	244	95	257	241	229	95
6. Transfers of Capital	1.313	1.775	1.504	85	1.251	1.657	1.594	97	1.306	1.921	1.806	94	1.308	2.002	1.633	97
7. Financial Assets	306	406	405	100	356	591	574	97	456	517	494	96	559	658	619	100
8. Active Finances	9	9	9	100	11	13	12	99	12	12	12	100	13	13	13	100
TOTALS	6.538	7.380	6.864	93	6.661	7.575	7.197	95	7.077	7.983	7.581	95	7.418	8.337	7.722	97

## NOTES:

P.I. - Initial Budget

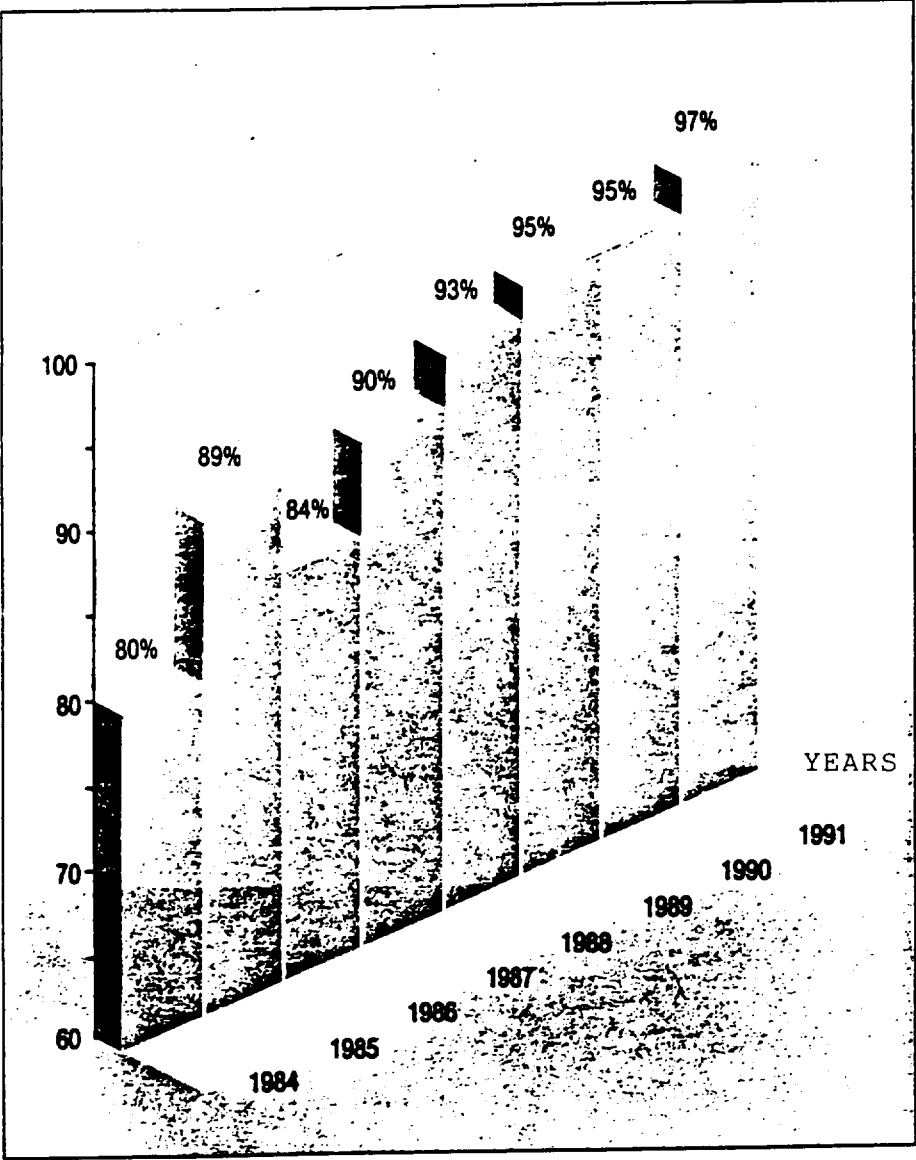
P.D. - Definite Budget

O.B. - Due at End of Each Year

%(1) - % of dues, vs. Definite Budget

\* The corresponding quantity of CERN's shares have been discounted (1984 and 1986)

\*\* During 1991 we produced a "Retention of Unavailable credit" of 365 MPTA. 326 in the Ch. 6 and 29 and Ch. 29, although not causing budget decrease, are funds that cannot be used. The % of Dues vs. Definite Budget is calculated by first discounting the 365 MPTA.



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 (Title Illegible)
 

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ENTITY	MPTA	%
Public Administration	266	11
Public Enterprises	696	29
Private Enterprises	231	9
European Community	604	25
Other International	208	9
Misc.	183	7
Financial Investments	214	10
TOTAL	2.402	100

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 (Title Illegible)
 

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Subprogram	(MPTA)	%
Fission	668	28
Fusion	590	24
Renewable Energy	327	14
Environment	465	19
Energy Technologies	123	5
Support Infrastructure	209	9
General Management	20	1
TOTAL	2.402	100

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YEAR	MPTA
1984	243
1985	649
1986	653
1987	714
1988	977
1989	1.265
1990	1.820
1991	2.402

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DISTRIBUTION OF PROJECTS, BUDGET INVESTMENTS  
AND AGREEMENTS, BY AREAS, IN 1991

1991	Number of Projects	Real Investments	Current Agreements
Nuclear Technology	20	351	56
Nuclear and environmental protection	9	196	64
Renewable energy	13	277	90
Basic research	10	227	33
Technology	10	367	42
Others	5	205	
TOTAL	67	1.633	320

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ANNUAL COMPARISON OF THE I+D PROJECTS OF CIEMAT, 1985-1991

Year	Number of Projects	Personnel Degreed	Auxiliaries	Real Investments (Mpta)	Achieved (%)
1985	45	169	236	899	73
1986	51	166	257	1.423	73
1987	55	283	373	1.189	85
1988	55	305	364	1.380	78
1989	52	335	355	1.398	71
1990	59	418	374	1.527	75
1991	67	447	425	1.453	78

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\* Refers only to personnel dedicated directly to projects, not counting the activities, related to the infrastructure of the Center.

\*\* Refers to real investments, related to the projects.

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INSTITUTE  
OF  
NUCLEAR TECHNOLOGY

TECHNOLOGY OF  
WASTE

STRUCTURAL  
MATERIALS

SAFETY  
TECHNOLOGY

INDUSTRIAL  
PROCESSES

RISK  
ANALYSIS

STORAGE  
SAFETY

## INSTITUTE OF NUCLEAR TECHNOLOGY

The Institute of Nuclear Technology consists of several specialized groups for research and development. These groups work in such areas as mineralogy, fluidized bed combustion, diagnostic technology, safety analysis, risk analysis, behavior of aerosols, storage safety, corrosion, fracturing, characterization and waste treatment, and dismantling technology.

Thanks to these specialized groups, we participate in programs within the CIEMAT, such as: nuclear fusion, nuclear fission, environmental technology and industrial risks.

With these internal activities within CIEMAT, we contribute externally to the activities of the European program I+D, the National Plan of Scientific Research and Technological Development and the program of Electro-technical research. This encompasses the activities within the area of scientific research and development. It also establishes the scientific component of these activities, which are complemented by the technological activities, done in collaboration with the industrial sector, nuclear stations, electric generators, ENRESA, Council of Nuclear Safety, engineering companies and services, and other industries of the energy sector or of the other production sectors.

The objectives of the Institute are:

- The research of the behavior of metallic structural materials at the energy plants, used under refrigeration or radiation, and increase of the knowledge of plant life span and the possibility of increasing the life span.
- The technological research and development of safety related to different types of accidents and improved industrial safety and reducing the risks.
- The research and development of technologies, related to waste management - radioactive and industrial in general - and the reduction of the

contaminant components through the adequate characterization, treatment and conditioning of the storage safety.

- The research and development of industrial mineralogical processes, treatment of solid and liquid waste, the energy field and the fluidized bed combustion.

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PERSONNEL DISTRIBUTION

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UNITS	TS	TM	Aux.	TOTAL
Support and Direction Unit	7	5	67	79
Waste Management	8	1	16	25
Industrial Processes	15	1	18	36
Safety Technology	14	1	4	19
Structural Materials	19	1	39	59
Risk Analysis	11	—	1	12
Storage Safety	11	—	2	12
Waste Technology	20	2	28	50
<hr/>				
TOTAL	105	11	175	292

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INVESTMENT AND INCOME (MPTA) OBTAINED DURING 1991

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UNITS	INVESTMENTS	INCOME
General	39.3	0.1
Waste Management	36.5	0.2
Industrial Processes	53.2	21.2
Safety Technology	48.6	9.0
Structural Materials	60.1	108.0
Risk Analysis	20.2	—
Storage Safety	18.1	23.1
Waste Technology	82.6	77.4
TOTAL	<b>358.6</b>	<b>239.0</b>

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## ACHIEVEMENTS DURING 1991

For achieving its objectives, the Institute is structured into six vertical units, with one support unit, and one service unit. The latter one provides technical support to the vertical units, and also accomplishes the task of waste management of waste generated at CIEMAT.

The six vertical units are:

- Industrial Processes Program
- Safety Technology Program
- Structural Materials Program
- Risk Analysis Program
- Storage Safety Program
- Waste Technology Program

The horizontal Industrial Risks program is assisted by the Risk Analysis and Storage Safety programs. The horizontal Environmental Technology program is assisted by the Industrial Processes and Storage Safety programs.

The group of activities mentioned above is distributed in the following thirteen projects, which are managed by the programs at the Institute.

## STRUCTURAL MATERIALS

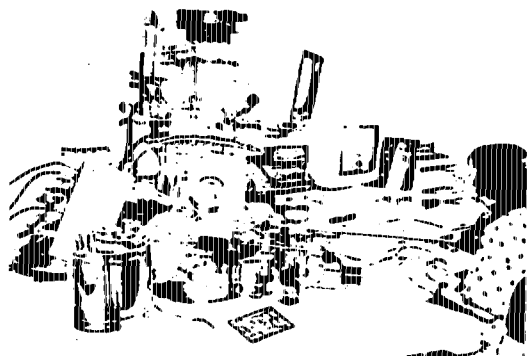
In this research program we study the mechanisms of degradation of the materials used in the energy production plants, with the objective of evaluating their useful life and increasing of their useful life.

## Radiation Effects in Structural Materials.

The object here is to understand the behavior of the materials, subjected to neutron radiation and thermal gradients, and also the possibility of recovery via thermal treatments.

Within the Electro-technical research program, included in the Coordinating Program of OIEA, we have initiated studies of the radiation effects on the fracturing of the container steel.

In connection with these studies we continued, during this year, the characterization of the container materials at Trillo, Asco I and Almaraz II, as a function of the integrated flux in each case. The data was entered in the data banks of each plant. This will assist the decision necessary for its safety and life extension.



AUGER system for surface analysis

Through the same Electro-technical research program, operating within the program for research of Fusion Technology at CEE as a part of the association CIEMAT-EURATOM, we have finalized the mechanical characterization of two alloys for low neutron activation, prepared in Spain. At the same time, and in collaboration with the "electric" union Fenosa, we have completed the construction of a prototype of a gamma-thermometer, by optimizing the design and the technology.

In collaboration with TECNOLOGICA, S.A. we have completed the irradiation of electronic components, used in the European space program, in order to understand the behavior under cosmic radiation. Also we have completed the irradiation of motors and electronic cables in order to study their degradation, thus evaluating their useful life.

#### Interaction Between Refrigerants and Structural Materials.

The object here is to study the phenomena of degradation, which are encountered in the primary circuit of the boiling water reactors, as well as the materials utilized in the pipes of the steam generators of the pressurized water reactors.

Within the Electro-technical research program we have developed two activities:



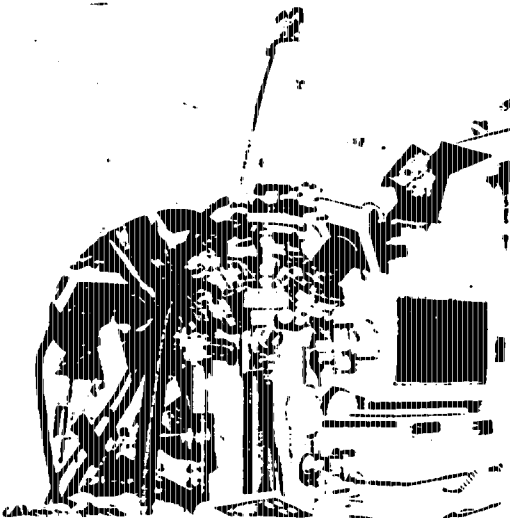
The first refers to the project of inter-granular corrosion, where we have studied the behavior of certain materials, based on the weldment of the primary circuit of the boiling water reactors. We also treated some alternative materials, using different chemistry and different impurities, in order to determine the growth speed of cracks and fractures.

The second is related to the National Project of Steam Generation, where we have finalized the corrosion tests at the primary side of the steam generators. We have completed the rebuilding of the installation for studying corrosion at the secondary side of the pipes of the steam generators.

Through direct contracts with the nuclear stations at Asco and Almaraz we have finalized the first phase of the studies of corrosion of alternative materials in aggressive media.

Also we have completed a number of work projects in characterization of cracks and fractures, produced artificially in pipe materials for steam generators.

Within the Materials program we have acquired and implemented equipment for surface analysis (AUGER and ESCA), capable of determining elements and composites on any surface and any depth desirable.



ESCA system for surface measurements

## SAFETY TECHNOLOGY

The nuclear safety research programs have as a fundamental objective the acquisition of scientific and technological knowledge, which would make it possible to improve the safety of operation of the nuclear plants, and at the same time increase their efficiency and useful life.

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Because of the complexity, and the associated costs of these programs, it seems fitting to promote collaboration on National and International levels. That has been our strategy during the last several years. On the National level

we participate in the Council for Nuclear Safety UNESA, and nuclear plants and the University.



Station for sample taking and optical measurement of particles in tests for retention of aerosols.

### Containment Technology.

The project of Containment Technology focuses all activities on the methods of analysis and experimentation in cases of serious accidents. The main objects are: the simulation and modeling of the transport mechanism, retention and chemistry of the fission products and aerosols, particularly in the regime of containment at the nuclear plants during serious accidents, and also the gathering of experience from different related effects.

As a result of the work performed through the years passed, in which the International participants played a decisive role (OECD-LOFT, PHEBUS-CSD, CEA-CE-PHEBUS-FP, EPRI-LACE and ACE, LACE-ESPANA), we now have a code system of updated calculations and qualified users. The system includes the nuclear plant infrastructure and its components: core (SCDAP, ICARE-2, CORSOR, FASTGRASS, VAPOR), primary circuit (TRAC-PF1, TRAPMELT, RAFT) and containment (CONTAIN, CONTEMPT, NAUA, IODE, IMPAIR-2D). In addition, installations and techniques are available for support analysis in the study of the behavior of aerosols in containment -- capable of simulating phenomena, representing accidental situations (relaxation pool retention, aqueous line, filtration, ventilation etc.)

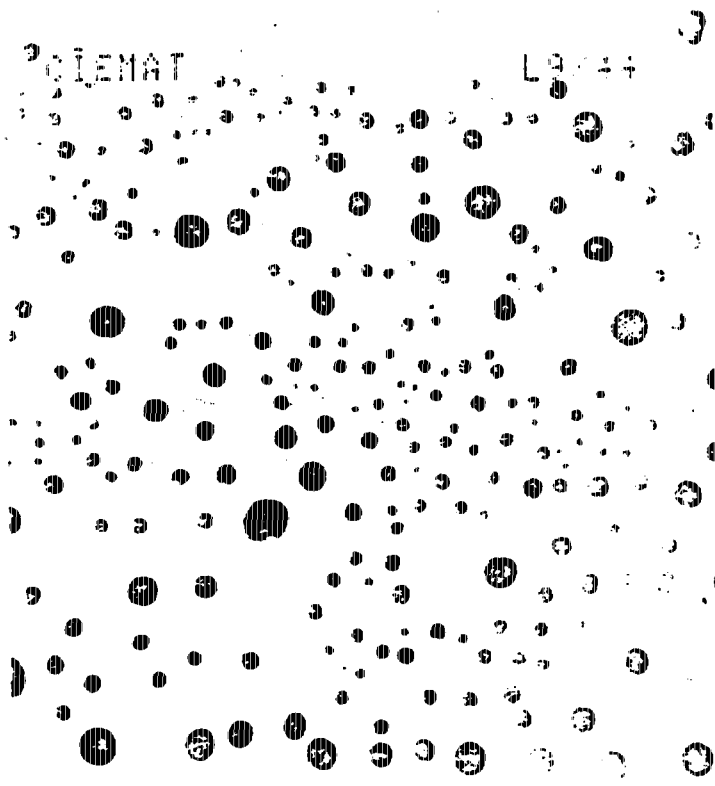
During 1991 the achievements in the different subprojects are as follow:

With the work on the project PHEBUS-CSD we concluded the studies of high pressure, and also those of low pressure. At the same time we concluded the analysis of the relative experiment of rupturing the control bars and the influence of core degradation.

In the common project PHEBUS-FT of fission product transport and aerosols during 1991, the work was focused on the analysis of the experiment FP-TO with ICARE-2, and especially on the behavior of the containment and its thermo-hydraulic aspects, aerosols and chemicals through the codes CONTEMPT, NAUA and IODE.

The integral tests of the multi-use installations for studying the behavior of aerosols and fusion products of the National project LA-CE-ESPANA, were completed, together with the start-up of the generation and aerosol characterization equipment (ICs), as well as measurements and control of the operation. With the execution of the 4 experiments, the first phase of the project was concluded, which permitted the determination of decontamination factors and the validation of the pool codes.

The hydro-dynamic studies of the rise of bubbles in the pool, which were recorded, and the analysis of the image, complement the experiments.



005107 25KV X4.00K 10.0um (a)

FIGURE MISSING IN FOREIGN TEXT

(b)

- a.) Particles of ICs obtained by electronic microscopy SEM
- b.) Distribution of different size particles by optical instruments.

Within the International project ACE we participated with the code IODE in the exercise "Benchmark", designed for comparing work in the area of containment behavior. In the context of the consortium ACE-ESPANA, we have had issued two reports to the state, in the area of the phenomenon of iodine under containment, during conditions of a serious accident.

## Diagnostics Technology.

Noise analysis was established as an appropriate tool for use in the programs for preventive maintenance of nuclear plants and conventional installations. While at first the analysis was designed around vibrations (with emphasis on frequency) now, due to advances in the information technology, new methods of using time as a factor are in use. From a maintenance point of view the applications involve: a.) detection of defects from incipient failures, b.) identification of malfunctions, and c.) diagnosis of causes.

During 1991 the following activities were developed in this area:

As far as thermocouple control and RTD (Resistance Temperature Detector) in Nuclear Reactors are concerned, the thermal noise was recorded and analyzed as a factor of time. Through feedback adjustments, the response time variations can be inferred, which permits to control the degradation of the sensor. This has been used in thermocouple measurements at the Nuclear Station at Trillo.

Pressure sensor analysis, via feedback methods, was initiated, for application and preventive maintenance in nuclear stations. The object is to control time of response of the sensors, and the associated sensor network. The work, for verification of the viability of the method with experimental data, continues.

Through analysis of the signal (neutron noise) in the BWR we can characterize the stability of the reactor, and identify the possible instability zones. From the studies of these signals, in the area of frequency and time, we can deduce values such as "decay ratio", coefficient of reactivity for cavities, etc. Studies of the measurements done at the nuclear station at Cofrentes, and other BWR nuclear reactors were initiated. Positive results have been reported in the area of diagnostics and operator assistance.

A systematic analysis of the vibrations in the Aeolian Park of Camarinas (La Coruna), were initiated in collaboration with the Institute of Renewable Energy

(IER). Results were obtained from measurements of the frequency, which characterize the spades and towers of the air-generators, and a method was developed for measurement of wind velocity. The creation of a database for the preventive maintenance for this type of installations is in progress.

In the methodology development area, the emphasis has been on the temporary series of analyzing the noise by feedback methods. The last development evolved around the ARMA mobile media feedback), MAR (multi-variable feedback), and MARMA (Multi-variable mobile media feedback) approaches. Methods were developed also for feedback analysis with time coefficients. These have great promise for application in the instabilities of BWR and also in the interpretation of brain wave signals in medicine.

#### RISK ANALYSIS

In this program we analyze qualitatively and quantitatively industry risks, focusing especially on the human factor.

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#### Human Factors.

The object of this project is to optimize the human contribution, and the safety of the nuclear installations, as well as to contribute to the increase of efficiency of the emergency communications in the Spanish community.

We coordinated and participated in the technical preparation of the Program for the Man-Machine System and the project Halden-Spain, which will be presented by UNESA at the Office for Coordination and Electro-technical Development (OCIDE). This program was conceived for the optimum use of the Spanish participation in the Project REACTOR HALDEN of OCDE. The participation agreement was signed by CINEMAT, which represented itself and other Spanish institutions for the 1991-93 period.

Spain is represented in the area of the Man-Machine System at the annual meetings of Halden Program Group, completed within the framework of the Halden-OCDE project.

Additionally we participated actively in the technical groups, organized for the development of graphic tools in the HALDEN-OCDE project ("Guidelines for design and evaluation of computerized systems for the man-machine interface". "Human Reliability Data".)

#### STORAGE SITE SAFETY.

Within the activities of fission nuclear energy, dealing with storage of radioactive waste, we planned the following projects:

##### Analysis of Storage Site Safety

The object of this project is to develop the methods and instrumentation needed for calculating and anticipating the behavior of the storage system, with life span of  $10^4$  to  $10^6$  years.

Just like in previous years, this year we continued the programs in two of the three subsystems, which define a storage site for highly radioactive nuclear waste -- the surrounding areas and geological formation -- and also the development of probability methods for analysis of the safety, as an integral part of any storage site.

In relation to the nearby areas, the study of temperature distribution in granite formations in the immediate vicinity was continued. Other studies, such as the long term behavior of the bentonite barriers, were initiated. Heat transfer codes were incorporated in the functions, which sum up the experimental results of the internal transformations.

The participation in the El Berrocal project activated the natural course of events of the work, already in progress, on the hydro-geological modeling and hydro-geochemical zoning of the granite areas. Independently of these developments, we are collaborating, since June 1990, with the Technical Geological Unit at the Ministry of Technology in the continuation of the work in the area of hydro-geology in situ.

A hydro-geological conceptual model was prepared and its development continues. In this area of activities the technical assistance of ENRESA is in the hydro-geo-radio-chemical interpretation of the samples from the Uranium Manufacturer at Andujar.

The development of the safety probability analysis is reflected in Annex IV of Agreement 13/87 between CINEMAT and ENRESA. In the analysis of the scenarios, the emphasis was on the meteorological SNL, in the methodology of AEGIS, and also on the long term geological simulation models GSM, FFSM and TIME2.

The incorporation of the Canadian methodology PSA and SYVAC was completed in connection with the code of transportation GTM-1. This code was developed during the ENRESA-JPC/Ispra contract and was published as EUR 13925 EN in 1991. Finally, with the advanced PSA methodology development of global analysis, an adaptation procedure of the English time dependence methodology VANDAL was initiated.

#### TECHNOLOGY OF RADIOACTIVE WASTE.

One of the most important activities of I+D, as related to the issue of radioactive waste materials, is the consolidation, within CINEMAT, of a group for investigation of the decontamination, treatment, reconditioning and characterization of materials of low and medium radioactivity. This was achieved by signing an agreement for collaboration with ENRESA, which initially included six projects of I+D, three of which are subsidized by the European Community Commission. ENRESA is also working on an agreement for collaboration in the area of characterization and behavior of used fuel in permanent storage sites.

We also must point the increase of subsidies by the Commission of European Community for project I+D for the final shut down of Reactor JEN-1.



## Characterization of Radioactive Materials and Waste.

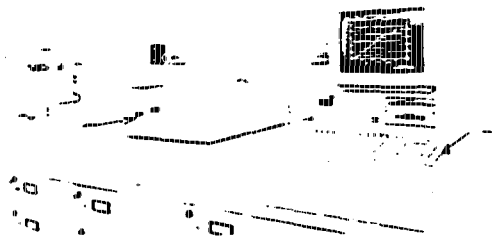
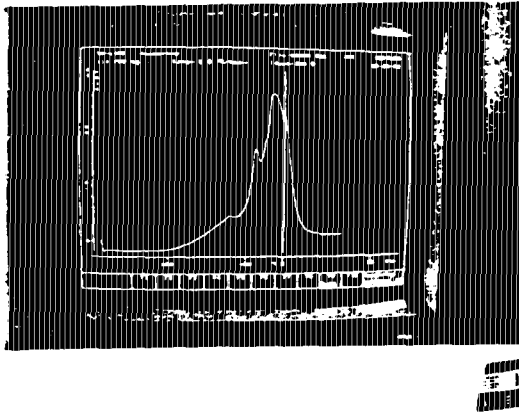
The fundamental objective of this project is the investigation, development and implementation of radio-chemical and radio-metric techniques for the identification and quantization of radio-nuclides present in solid and liquid materials and radioactive waste.

The collaboration with different CIEMAT projects, consisting of radio-chemical control, as needed for its activities, continued during this year. This resulted in more than 3,000 analyses of 1,230 samples.

The implementation and optimization of non-destructive characterization techniques, after establishing the necessary parameters for locating the most radioactive zones, was continued. A system for automating the characterization equipment was developed also.

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Through agreement with ENRESA, the E.C. initiated the project I+D for the purpose of radio-chemical analysis of long lived beta rays of radio nuclide emitters in nuclear stations, and the differences among these and other known gamma radio nuclide emitters. This will permit the empirical calculation of the beta emitters, and characterization through gamma spectroscopy via non-destructive methods of analysis. This should establish the new radio-chemical study techniques for preparation of samples for the study, ion-exchange resins and concentrates from the evaporators, originating from different nuclear stations in Spain. The following foreign organizations participate in the I+D project: CEA, France; KWU, Germany; AEA Technology, UK; ONDRAF-NRAS, Belgium; and ENEA, Italy.



Analytical equipment for thermal analysis, used for conditioning of radioactive graphite.

#### Treatment of Low and Medium Radioactivity Wastes

The object of this project is to complete the experimental studies of the treatment and immobilization processes, which assist in the waste conditioning process, thus meeting the established requirements for transportation or permanent storage.

Within the ENRESA collaboration framework, we continued the studies of characterization and treatment of liquid waste and their possible incineration. We have initiated characterization experiments with irradiated graphite covers, originating from the nuclear stations Vandellós I.

Also in collaboration with ENRESA and in association with CEA of France, we have initiated a study of lixiviation of long life beta emitters of destruction processes, present in wastes from nuclear stations immobilized in cement. This project is subsidized by a E.C. Commission.

During 1991, we completed an experimental study, with the object of determining the optimum parameters of cement immobilization of the ion-exchange resins and concentrate from evaporators from the nuclear stations Jose Cabrerra. We have completed also experiments of lixiviation of the obtained samples.

#### Research of Highly Radioactive Waste.

The principal objective of this project is the experimental tests of the behavior of the exhausted nuclear fuels and the materials for storage capsules, used in the geological media, selected for this purpose, with the goal of obtaining data for the conceptual design. Another objective is the study of the behavior of used fuels during the intermediate storage.

The completed activities are related to the project LOFT, which is already completed with experiments of lixiviation of irradiated and non-irradiated  $\text{UO}_2$ , and with project HALDEN of the OCDE.

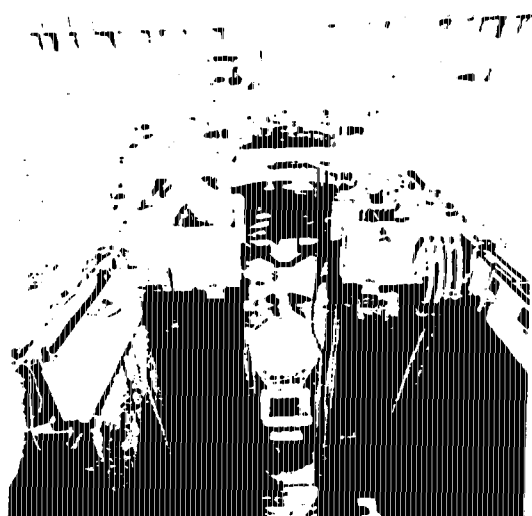
As far as the project LOFT is concerned, we have published a book, which reveals all aspects of the physical and chemical processes, which take place in the core of a nuclear reactor as a consequence of a serious accident.

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On the other hand, within the experiments of lixiviation of  $\text{UO}_2$ , a member of the research group was despatched to Kernforschungszentrum GmbH at Karlsruhe, Germany, where he is working on related aspects of the lixiviation, of spent fuels (irradiated  $\text{UO}_2$ ) in brine.

This activity was assigned through an agreement between KIK, ENRESA and CIEMAT. The tasks, completed at CIEMAT were primarily in the area of equipment and start-up a of characterization lab, as well as the initiation of tests of irradiated  $\text{UO}_2$ 's lixiviation in brine.

Through the agreement with the HALDEN reactor, signed between OCDE and CIEMAT, we have completed the tasks for following the related activities of characterization of irradiated fuel.



Pool of reactor JEN-1, after the nucleus structure has been removed.

#### Technology for Nuclear Plant Shutdown.

The object of this project is the dismantling of the experimental reactor JEN-1 and also to obtain the maximum possible scientific and technological information on the techniques for processes for decontamination of metallic materials, for application in nuclear station shut-down procedures.

The tasks of research of underwater plasma separation and that with consumable electrodes, decontamination and melt-down of the aluminum components of the reactor JEN-1, were continued. In this task we received the collaboration of the University of Hanover, ENRESA, ENSA and LIENSA. The project is subsidized by E.C.. We also continued the research work in the area of treatment and conditioning of radioactive graphite, originating from nuclear stations.

The principal activities, completed are as follow:

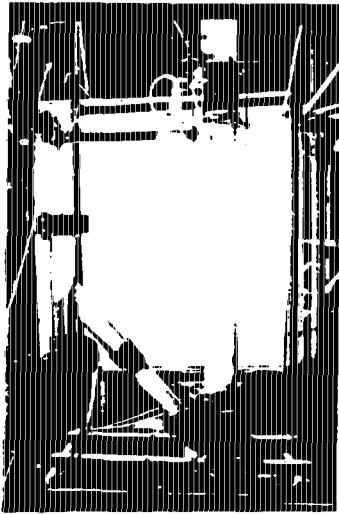
- Experiments of underwater of inert aluminum with plasma and consumable electrodes, for the determination of the cutting process parameters.

- Project for a melt-down installation and first tests with non radioactive aluminum.
- Experiments with decontamination of inert aluminum with different chemical agents.
- Non-radioactive graphite samples, originating from the nuclear station at Vandellos I and the reactor JEN-1, were characterized. These included porosity, surface activity, analysis of organic and inorganic impurities and water content.
- The characterization of radioactive graphite samples, originating from nuclear station Vandellos I, were initiated, and tests for separation of tritium, which was present in these, were done as well.
- The study for conditioning of non-radioactive graphite through metallization, was initiated.

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## INDUSTRIAL PROCESSES

This research program shared the load with the horizontal program of Environmental Technology, and is focused on the development of technology and processes in the energy field, the environment and mineralogy. Its effort is directed in two principal directions: combustion/incineration in fluidized bed, and operations for separation, as applied to effluent liquids and hydro-metallurgy.



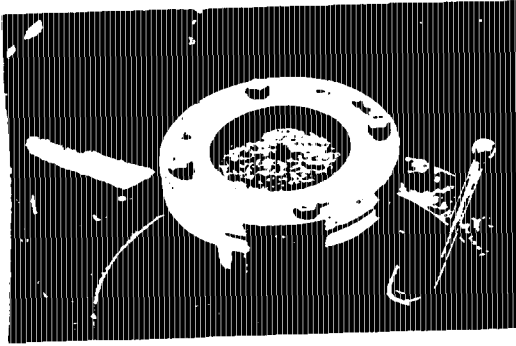
Cold fluidized bed. Detail of the exit transfer valve.

#### Combustion Technology.

The object of this project is the application of fluidized bed technology, the carbon combustion for clean use of the same, and also waste incineration in order to minimize and/or to eliminate its environmental impact.

In the area of carbon combustion, we established a database, related to the experimental information on fluidized bed combustion, which permits the development of mathematical models. Also we advanced the project of combustion of black lignites in fluidized bed, completing the experiments of combustion in situ, the studies of limestone reactivity and the effect of its porosity, as well as hydro-dynamic studies (cold) with isocynetic drills.

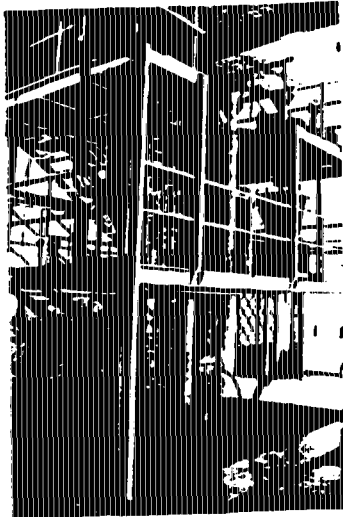
In the area of development, we signed an agreement with the National Electrical Enterprise (ENDESA), and with SCAP EUROPA, SA, for the OPTIMIZATION OF COMBUSTION AND ENVIRONMENTAL IMPACT OF FLUIDIZED BED FURNACES, utilizing experts and systems for predictive adaptation control, at the fluidized bed furnaces of CIEMAT.



Viewport. View of fluidized bed at 850°C.

We continued the collaboration with ENDESA in various areas of the characterization of fuels and absorbants at the 175 Mw plant at Teruel, absorbants for the CT of Almeria, studies related to the start-up of ESCATRON. We also participated in studies of the distribution of boron in the Teruel area.

We initiated a new three year project, which was formalized through a contract for mathematical modeling and study of the environmental behavior of ashes, originating from circulating and pressurized fluidized bed combustion. All this collaboration was made possible through the signing of five different contracts with ENDESA.



Pilot plant for "Circulating Fluidized Bed Combustion"

We represented Spain in the participation agreement for fluidized bed combustion with the International Energy Agency (AIE), signed during this year.

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We are following again the course of "Fluidized Bed Combustion" and continue the activities in this area, working with urban and industrial waste.

In this area we proceeded with the study of characterization of used oil for their combustion in fluidized bed, adapting the pilot plan for this type of combustion.

In the area of waste management, we prepared and initiated a project, called "Elimination of Tanned Leather Waste" (shoe leather sector), thus completing the term of basic studies and engineering. This three year project is under development with the collaboration of INESCOP (Spanish Institute of Shoes, Research Association). Its objective is the calculation, design, assembly and start-up of a demo plant, capable of eliminating 2,500 tons/year of this product. This project is subsidized by the program MEDSPA or the CE and the Program PITMA of MICYT.

#### Treatment of Minerals.

The object of the present project is, on one hand, the application of the basic operations of separation and elimination of heavy metals, anions and contaminating organic matter, originating from industrial waste waters, and on the other, the development and application of a group of operations for mineral ores, and other products, which could be of economic interest.

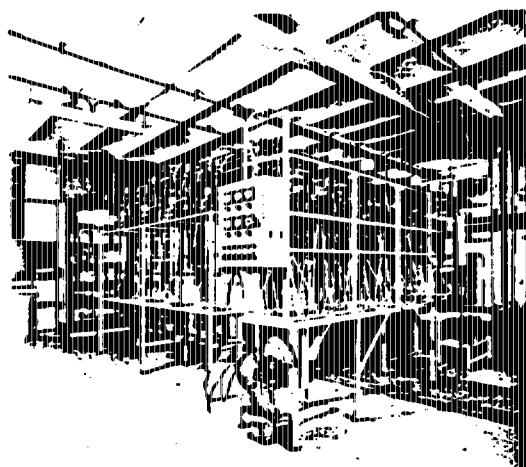
In the area of treatment of minerals, during 1991, we completed the rare earth and minerals studies from Gallineiro, under a contract with Ercros. That was done after we defined the conditions for the work in this mineral complex, and prepared the solutions for the study of separation via extraction with solvents.

By a request from HUNOSA, we made a study of the wash of Batan.

We initiated a study of separation of rare earth by liquid-liquid extraction in a project, which was presented to, and approved by, CICYT. The experiments



for elimination of heavy metals were initiated in 1990 and the work continued in 1992 with experiments for elimination of anions with different types of resins, and elimination of different organic materials by active carbon.



Installations for ion exchange, and ion extraction with solvents, at the laboratory for hydro-metallurgy.

On the other hand we started the procedures for determining the DBO, DQB and total carbon, which are important parameters for characterization of liquid effluent.

In 1991 we finalized an agreement with ORGEMER, after completing the necessary visits and other formalities.

We completed the definition and advance of the first multi-use pilot plant, and installed the ion exchange equipment for the treatment of liquid effluent.

#### OTHER ACTIVITIES

At the Institute of Nuclear Technology, in addition to the research and development activities in the area of nuclear fission and the participation in the horizontal programs of Industrial Risk and Environmental Technology, we develop the following activities:

## Management of Radioactive Waste and Engineering

We support the operation of the radioactive installations of CIEMAT, managing their waste and facilitating this elimination via adequate treatment and conditioning and then sending them to the storage facilities of ENRESA. In collaboration with this enterprise we condition the radioactive waste generated by the small production facilities, such as hospitals, research facilities and universities, and equally proceed with intervention in cases with radioactive materials, according to the Resolution of the General Directorate of Energy.

In the area of waste management, during 1991, we published several documents, regarding the safety of the different installations, of conditioning and storage, solid waste treatment plants IR-17, and storage facilities for organic waste IR-27. The latter is a new creation, which was licensed by the Resolution of the General Directorate of Energy. At the same time in Unit 73 we received sources of Ra-226, with 294.5 mCi. 275 various sources with 9.588 mCi, 22.6 m<sup>3</sup> of solid waste with 3,171 mCi, 4.3 m<sup>3</sup> of liquid waste with 98 mCi and 65 l of organic waste with 0.1 mCi. We produced on inventory of  $\approx 2$  m<sup>3</sup> of liquid waste with activity of .275 mCi, 35.77 m<sup>3</sup> of solid waste with activity of approx. 3.915 mCi in 188 packages and 2 sources with 850 mCi in one package. Finally we transferred to storage at El Cabril (ENRESA) 186 packages with activity of 1215 mCi.

This unit initiated engineering activities (design, fabrication, assembly and maintenance) for support of the research projects of the Institute, and also participated in the dismantling activities in the installations, in response to the direction given by the General Directorate of CIEMAT.

The department of Dismantling of nuclear and radioactive installations, dismantled the CORAL-1 reactor (IN-O2) and has completed operations, related to the dismantling of the development plant of fuel elements for research reactors (IN-O3). At the same time we have presented to the competent authorities, CIEMAT's general plan for dismantling, and for decommissioning of installations, with the corresponding procedures and manuals.

# PUBLICATIONS

	1	2	3	4	5	6	7	8	9 *
National magazines	1	1	—	—	—	—	—	—	2
Foreign magazines	—	1	—	—	—	—	—	—	1
CIEMAT reports	—	8	—	—	—	—	—	—	8
Congressional memos	5	12	8	1	4	5	—	2	37
Books	1	—	—	—	—	1	—	—	2
E.C. reports	1	1	—	—	—	6	—	—	8
Enterprise reports	7	10	—	1	—	3	2	—	23
Reports by areas	17	9	47	8	16	14	—	—	111
Procedures	—	1	11	—	—	8	3	—	23
Safety	—	—	—	—	—	6	8	—	14
Thesis	1	—	—	—	—	—	—	—	1
Nuclear energy	—	—	3	—	—	—	—	—	3

Key: 1. Industrial Processes  
2. Safety Technology  
3. Structural materials  
4. Risk analysis  
5. Storage safety  
6. Waste technology  
7. Waste management  
8. Institutional direction  
9. Total

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## AGREEMENTS SIGNED DURING 1991

## ORGANIZATION OR ENTERPRISES

### Institute of Nuclear Technology

- Storage in CIEMAT under higher order than CSIC. CSIC
- Specific agreement for collaboration on the Master plan for Nuclear Energy UAM

### Industrial Processes

- Project for optimization of the combustion and environmental impact of the fluidized bed furnaces. ENDESA-SCAP, EUROPA, SA

### Safety Technology

- Confidentiality agreement GE

## Risk Analysis

- Methodology based on knowledge of the identification of risks (TOMHID) CEE
- Agreement on the OECD Halden Reactor Project from 1.1.91 to 31.12.93 HALDEN
- Study of safety and risk analysis in the industry. CEE
- Project TOMHID. Program STEP. United Kingdom Atomic Energy APEA Technology. University of Sheffield R.S. - National laboratory. JRC-Systems Engineering Institute - Center of Technical Research in Finland
- Completion of studies in the area of man-machine interaction; computerized systems for operation support for complex installations and advanced control rooms. UPV

## Waste Technology

- The project I+D for the closure of the reactor JEN-1, derived from contract (CE FI2D-CT90-0023) ENSA
- The project I+D for the closure of the reactor JEN-1, derived from contract (CE FI2D-CT90-0023) LAINSA
- Lixiviation of pure beta emitters and long lived radio-nuclides of semi-disintegration in real or simulated immobilized waste in FI2W-CT90-0032 (DTEE) EURATOM
- Related preparation services for interchange of conditioned waste (SWAP), property of CIEMAT and stored in BELGOPROCESS. BELGOPROCESS
- Contract n FI2D-CT91-0062 (DCEO) "Decommissioning of JEN-1, experimental reactor Phase 2" ENRESA-LAINSA-CEE
- Annex IV of the conference of the association CIEMAT-ENRESA. Technological research and development in the area of low and medium radioactivity waste contamination and characterization. ENRESA

- N PIZ W-CT90-0032. Basic leaching test for pure beta emitters and long lived emitters in real or simulated wastes. CEE

- Decommissioning of JEN-1 (FIZD)

CF--UNN--HANNOVER

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## HORIZONTAL PROGRAM FOR INDUSTRIAL RISK

There are several institutes contributing to the Horizontal program of Industrial risks. These are: the Institute of Nuclear Technology, Environment, the Directorate of Technology and the Institute of Energy Studies. This program was conceived by the Decree 82/501 of the E.C. and decree 886/88 for major accidents. It is geared for development and verification of methodology for safety of high risk industries and for emergency planning and management.

The activities during 1991 were structured in the following manner:

### Information and Standards

The object here is to gather the maximum information possible, as related to the existing standards for prevention of serious accidents.

There was interest shown, during 1991, for the analysis of the Spanish standards by the E.C. and also for the correction and completion of guides and manuals, which were started in 1990, and which -- according to publication RD 952/1990, must be completed.

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The principal completed activities were reflected in the following documents:

- Obligatory guide for notification of major accidents
- Guide for cataloging of industrial activities with risks of major accidents and for the presentation of information, simplified by the industry (Update, combining RD 886/1988 and RD 953/1990.)

- Compilation and analysis of registration and standards related to major and conventional accidents.

### Risk Analysis and Source Terms

The general purpose of this project is to obtain and validate methodology for risk analysis and source terms, as related to major accidents in Spain.

For the achievement of this purpose we have initiated the following activities:

- Study of the software packages (TNO) and WHAZAN (Tca), which include models for prediction of consequences from industrial accidents, physical effects caused by fire, gas escape or explosion.
- Study of package CARA (Tca), or an integrated package of diverse methodology of analysis of dangers and failures.
- We signed a contract with DG XII of CCEE, related to the initiation of project STEP-TOMHID, or the development of an expert system for the identification of dangers in the industry. The CIEMAT is heading the first part of the project, and leads the European teams, participating in it. It involves the following tasks, according to the programming: revision and comparison of the technology ad hoc, and determination of the necessity for potential use of the hardware under development. With this purpose we presented the project objective and a questionnaire prepared by CIEMAT in several countries. In Spain we have made a presentation to the autonomous communities of Andalucia (Cadiz, Sevilla, Huelva), Valencia and Cataluna (Barcelona.)

### Human Factors

This project has as a general objective to contribute to the optimization of the treatment of the human factor in the conventional high risk industry, by the completion of the following activities:

- Analysis of work places.

The objective is to prepare manuals, which will guide the analysts and specialists, for the evaluation of the human contribution to the risk factor, and in their desire to contribute to the safety studies of the installations, affected by the Seveso Decree. This activity will be executed in two different phases:

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- a.) Revision of the existing "Techniques and models of human failures, and their implicit and explicit consideration in the methodology for the identification of dangers and risk analysis"
- b.) Optimization of these methods, through their adaptation in Spanish prototype installations, affected by the mentioned decree.

The methodology developed in 1992 for the identification of factors, which can contribute to the occurrence of human errors (questionnaire for interviews and list of verification for direct observation), has been applied during this year. The objective was to prove its validity in four Spanish installations, which use chlorine in their production.

This project is developed in cooperation with the National Institute of Safety and Hygiene, and the Faculty of Psychology of the University of Madrid.

- Social perception and risk communication

The objective is to develop optimized models, which would make it possible to develop efficient information channels within the Spanish population, communicating the risks associated with the installations affected by the Seveso Decree (RD 886/88 and 952/90). This activity is developed in two phases:

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- a.) Revision of the risk communication models and community experience on this subject (completed in 1990).

- b.) Selection and/or optimization of most appropriate models in the country through implementation of pilot cases.

During this year we held, together with the Faculty of Psychology and Sociology of the University of Madrid, a contest in order to obtain a subsidy from CICYT.

By a petition from the Institute of Renewable Energy at CIEMAT, we initiated a study of the "Attitudes, Values and Beliefs of the population affected by the conditions at the Aeolian parks at Cabo Villano and Tarifa"

Dispersion of Contaminants in the Atmosphere.

The object here is to develop the knowledge base for characterization of the process of dispersion and transformation of toxic products vented into the atmosphere, as a consequence of an accident in the chemical industry.

The activities completed during 1991 can be summed up as:

- 1.) Classification of synoptic situations and predictions of the wind in some selected storage places.

Within this part, we have to point out the studies done in El Cabril, as a representation of the influence exercised by a small valley in a zone of intense sunshine. We also initiated the classification and wind analysis in the basin of Madrid, and its evolution during the day, as a function of the synoptic condition during fall and winter seasons.

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- 2.) Modeling of the atmospheric dispersion

To cover this section we have selected, acquired and analyzed the dispersion of dense gasses, capable of simulating the characteristics of different types of accidents in the chemical sector. The preliminary analysis and the comparison between them permit us to select a model, which is most appropriate for the type of accidents for which it is considered.



We have started several models of passive gas dispersion, which can be executed in real time, with data obtained at the moment of the accident. Application and adjustment to geographically complex terrains are now actually the object of study.

#### Dispersion of Contaminants in the Water Media.

The project has as the objective to contribute to the development of a system of assistance for decision making during emergency situations in case of accidents in high risk industries. It consists of three parts:

- a.) Define the water media contamination producing cases -- under emergency conditions. That means specific data, related to the accident and the condition of the contaminating media and/or the great uncertainties related to them.
- b.) Incorporate and/or develop models of adequate calculation of the initial conditions and an outline consistent with the cases, and the liberation and evolution of the contaminant.
- c.) Design the data bases, necessary for the system management.

Following the activities in the area of surface waters, initiated in 1990, for assembly of tables for the dispersion, as a function of the physical, geometric and hydro-geological characteristics, which can be encountered in the dispersive media and the identification of the principal processes, which take place in the surface water media (rivers and reservoirs), we assembled a simplified initial model of the system to assist in the decision making process.

Reaching this point, we saw the convenience of overcoming the individual limitations of the available analytical model by preparing a new model, which permits us to treat the geometric and seasonal variables of the source term with great agility, and which facilitates the interchange between the different sections, subdividing the fluvial flow for reasons of its volume. The development of this model is under the charge of the Unit of Information applications. Parallel with this we are considering the

details of the treatment of the Meandrian sections and also completed the hydro-geological database of the river Ebro, which was initiated in 1990. This database, in its spectrum and details, corresponds to the model foreseen in the initial design of the project.

The river contamination data table, initiated in 1990, was concluded, after the revision of the initial criteria for classification and identification of the hydro-geological systems. The following criteria were followed: lithological, hydro-geological (potentials, flow and regime) and transport.

The selection and implementation of analytical models of flow and transport were transformed into simpler models of the numerical type (finite differences) and "random walk" type applicable to the determination of the matrix of cases, particularly to quasi-three dimensional flow and/or migration.

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After the design of the databases, needed for the management of these models, we initiated the data entry, needed for determining their functionality. This task will be accomplished during 1992, after the assembly of the models and the corresponding cases of contamination.

## Effects on the Health

This project has as an objective the evaluation of the health problems, arising from exposing the population to potentially toxic chemical products, liberated in the air, as a consequence of an accident. In addition to the response speed, the evaluation of the expected effect should be calculated through a data base, created from data taken from short duration exposure to product(s) released in the air as a consequence of an accident. Without a doubt, this type of information is even more important than the already available (that for prolonged exposures of relatively low concentrations of toxic products.) Starting with the analysis of the situation, we were able to define various fundamental areas of action among which we can distinguish representatives from the work done so far, as follows:

In the area of quantitative methodologies, we made advances in the area of dosimetric modeling and calculations of the effective dosage, as a first stage of establishing the relation of the exposure to different metal

compositions. We developed a comparison model for description of the deposition, elimination and systematic retention of the compounds of beryllium.

In the area of semi-quantitative methodologies, we developed a method (ARIES; applicable to industrial risk for evaluation of health effects), which permits us to circumvent the present model deficiency. This will assist us with the semi-quantitative evaluation of the risks. ARIES is an evaluation software, based, on the one hand, on the systematic analysis of the existing information of some chemical products, and on the other, on the systematic treatment of predetermined aspects of the same.

We have developed the first prototype of the system, which includes two complementary sequential stages. The first of these estimates the short term sequences of inhalation of several toxic products included in the Seveso decree. The evaluation is initiated with the processing of the concentration together with different selected indices of toxicity, which serve as input data of the different models of pulmonary retention, disturbance, extrapolation etc. This first stage represents the temporal evolution of the diverse effects of the products, as a consequence of inhaling the studied products. The second stage completes the results through a system, developed for the selection of complementary information, filtered by the content of the data base of toxic chemicals, residing in that system.

#### Data Processes and Expert Systems.

The development of this project, during this year, is focused on the following aspects:

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1. Collaboration in, and start up of, information model, including the contamination case for the surface and underground aquatic media.
2. Synthesis of the logic, necessary for input in the system of the available information on atmospheric contaminants.
3. Inclusion in the model of the first phase of evaluated health effects, produced by contamination, as estimated by the information system.

The obtained results are as follow:

- Presentation, in June, of the information model, covering the mentioned aspects, installed in a database of a unique code of dispersion (TU-BE + STTUBE), whose output information can be utilized as a level of contamination for the qualitative estimation of the foreseeable health effects, level of the information messages and the graphic threshold scale.
- The preparation of a diagram for environmental studies, as a representation of the factors to be considered in tackling the subject of atmospheric contamination, where we have to consider the succession of actions, needed to cover the maximum objective of first level (follow the evolution of the contaminant cloud).
- Proposal for the preparation of a unique code, capable of covering the different problems of the contamination scenarios. This model will make it possible to eliminate the limitations of the existing codes, and will solve the problem with interchange between the different sections.

This involves a problem of integration of the diverse hardware, needed for this project, and in particular: databases, information systems, code for conventional calculations and user-friendly interface. All this is to be included in the hardware, which is connected into the network.

This complexity is reflected in a paper, presented to the second National Congress of Oracle Users, Spain, which appears in an Information Bulletin #20, under the title "Experience in the World of PC. Hardware Integration".

HORIZONTAL PROGRAM OF ENVIRONMENTAL TECHNOLOGY.

Mitigation techniques of the industrial contamination of water media and recuperation of contaminated soils.

The purpose of this project is to identify, evaluate and develop corrective techniques for contaminated water and soils, resulting from industrial activities.

During 1990, the project activity was focused, according to the schedule, at the conceptual analysis of the procedures and technologies for correction of contamination impacts, bibliographic studies of conventional industrial contamination, and in the nuclear contamination of the soil-water system.

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The project applies behavior analysis, from the environmental point of view, of the environment-contaminant system for anticipation of the water media response through utilization of geo-chemical and hydro-geological simulation models of flow and transport. As a result of this work, we will obtain industrial systematics and corrective measures, and a system of assistance for making decisions on storage types. The selection process will take into account the available real cases.

At this point, we have to point out the connection between this project and the sub-project "Toxic and Dangerous Waste" from the project "Dispersion in the Water Media", which is a part of the Horizontal Program of Industrial Risk.

#### Waste Combustion.

In the area of waste combustion, we have initiated a study and characterization of used oils in fluidized bed combustion, adapting a pilot plant for this process.

Also in the waste management area, we prepared a project "Elimination of Tanned Leather Wastes" (shoe leather section), completing the basic studies as part of basic engineering. This project of three years is undertaken with the cooperation of INESCOP (Spanish Institute of Shoes. Research Association). As a result, we completed the calculations, design, assembly and start-up of a demo plant, capable of eliminating 2,500 tons/year of this product. This project is subsidized by the program MEDSPA of E.C. and the program PITMA of MICYT.

## Treatment of Liquid Effluents.

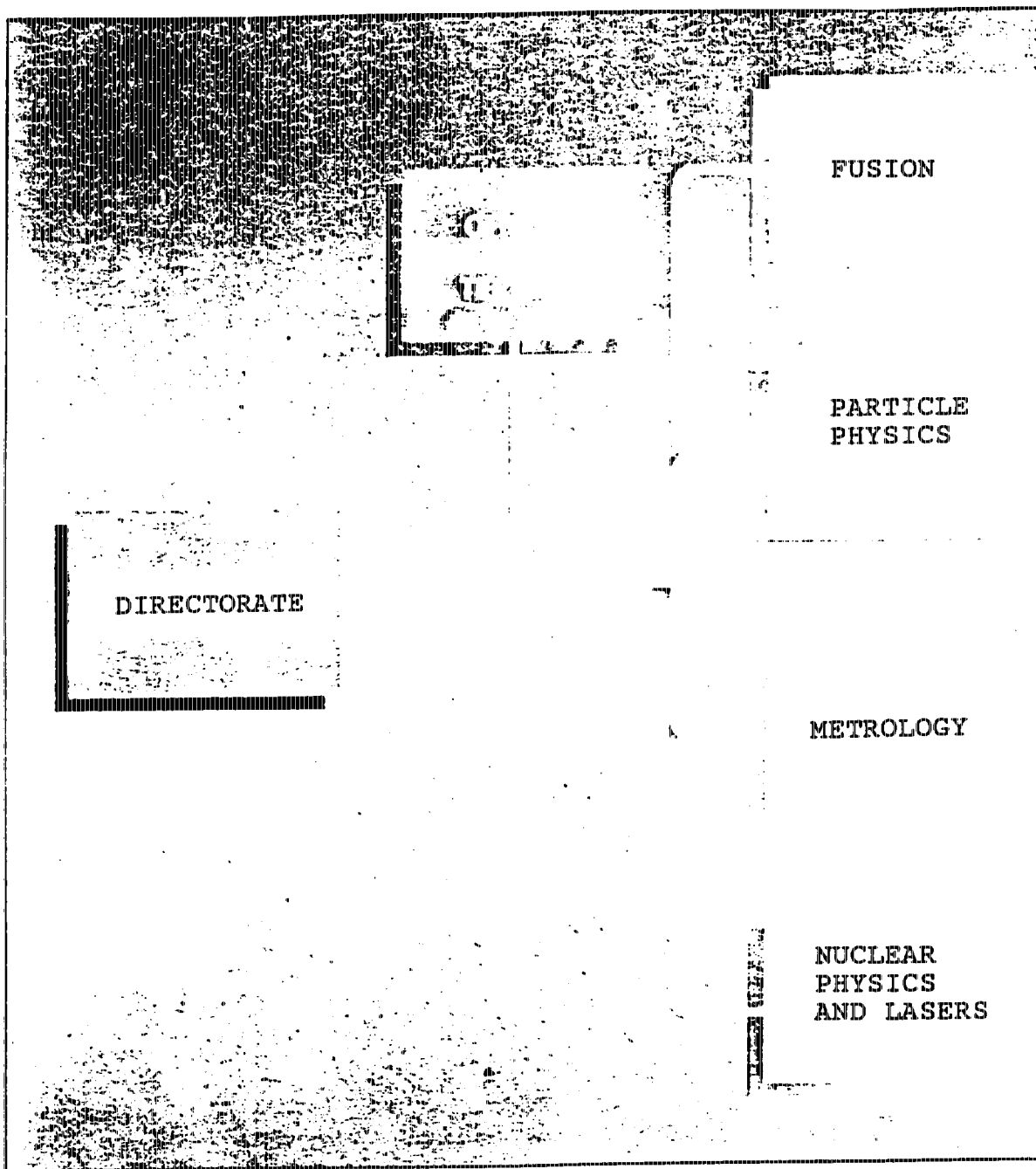
The tests for elimination of heavy metals were started in 1990, and are still continued in 1991. The focus is on anion elimination with different types of resins, and also on tests for elimination of organic matter with activated carbon.

We have also started the proceedings for determination of DBO, DQO and total carbonates, which are important parameters, when referring to characterization of liquid effluents.

In 1991 we finalized the agreement with ORGEMAR, after we completed the necessary visits and presented the final report.

As far as the multi-use pilot plant is concerned, we defined its parameters and proceeded with its implementation. We also acquired, installed and operated ion exchange equipment for treatment of liquid effluents.

INSTITUTE  
FOR  
BASIC RESEARCH





## BASIC RESEARCH INSTITUTE

The Institute for Basic Research is responsible for promoting and implementing I+D projects in the areas of Fusion by Magnetic Containment, Experimental Particle Physics and Radiation Physics, as related to Metrology of Ionizing Radiation, and Atomic and Laser Physics.

In order to continue these projects during 1991, the Institute for Basic Research used the following human resources and materials, as of December 31:

## PERSONNEL DISTRIBUTION

UNIT	TS	TM	AUX+LAB	TOTAL
Directorate	2	—	1	3
Technical Support Unit	0.5	2	13	15.5
Fusion	49	5	27	81
Particle Physics	17	1	6	24
Metrology	15	—	11	26
Nuclear and Laser Physics	6.5	—	1	7.5
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TOTAL	90	8	50	157

It is worthwhile pointing out that the personnel number increased, as compared with the previous year, and especially that of the Fusion Division.

In addition to the Institute's own personnel, we counted on the assistance of people from other Institutes or Directorates, which consisted of 2 degreed and 10 auxilliary personnel, mostly from general offices, for help with the Fusion program.

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USE OF INVESTMENTS AND INCOME OBTAINED (MPTA) DURING 1991		
Units	Investments	Income
Fusion	418,4	591,5
Particle Physics	26,9	14,3
Metrology	30,5	14,7
Nuclear Physics	5,8	—
<b>TOTAL</b>	<b>481,6</b>	<b>620,5</b>

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In the case of the Particle Physics division, we have to add to its expenses the quantity of 32.7 PMTA, as contribution from CIEMAT. This is the cost for construction and operation of the equipment for the experiments L3 and UA1 of CERN, in which we participate and in fusion. 23.1 MPTA is the Spanish contribution to the budget of JET.

In continuation, we will summarize the completed activities and their results for each of the research projects of the Institute during 1991.

## ACHIEVEMENTS DURING 1991.

### FUSION BY MAGNETIC CONFINEMENT.

The activities of thermonuclear physics by magnetic confinement were determined by the Agreement of the Euratom Association/CIEMAT. They have as an objective the active participation in the I+D program for development of thermonuclear fusion as a future alternative of energy generation. The development of this program is an object of extensive National and International collaboration.

During 1991 the activities of the Fusion division were developed as follow:

Scientific exploitation of Tokamak TJ-I

Design and construction of Thorsatron TJ-I-U

Design and construction of the Flexible Helicac TJ-II

Theoretical studies of plasma physics and stellarator heating.

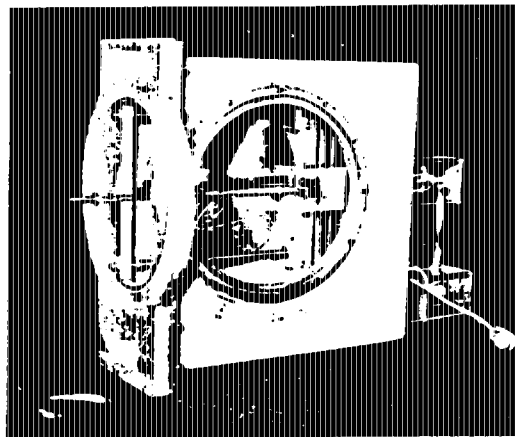
Insulating materials for fusion.

### SCIENTIFIC EXPLOITATION OF TOKAMAK TJ-I

The completed activities include studies of turbulence, plasma-wall interactions, particle confinement, particle and energy confinement and diagnostic equipment development.

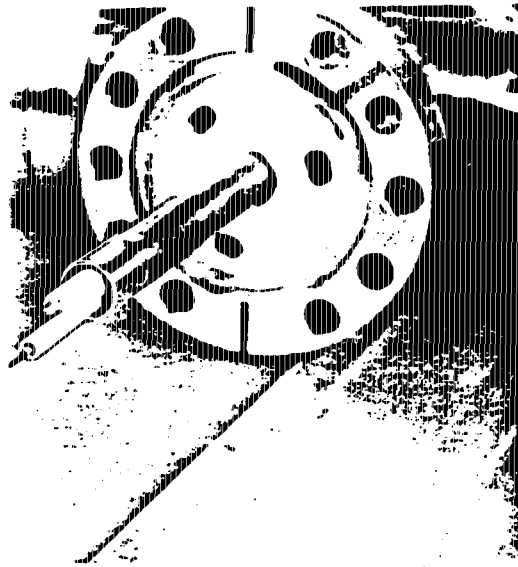
Turbulences: We have measured the turbulences in the plasma border regions of TJ-I, and in particular the velocity

changes in proximity to the limiter. This was done during analysis of the electrostatic fluctuation characteristics, magnetism and temperature in the region, and the relation between the poloidal and radial magnetic fluctuations. We initiated studies for the determination of the role of the anomalous ionic heating and the turbulence on the behavior of the temperature profile of the impurities in TJ- I. We developed a quantitative model which takes into account the effect of the turbulences on the shape of the spectral lines.



System for measuring the magnetic surface in TJ-I

Within the agreement of collaboration with ORNL and IPP, we made measurements and completed comparative studies of the turbulences at the plasma border regions in the stellarators ATF and Wendelstein 7-AS. In both cases we observed that the velocity of the poloidal phase of the fluctuation changes the sign in proximity to the last closed surface of the flux. The obtained results are very similar to both mechanisms of the shade zone of the limiter (scrape-off layer.) Also we completed studies of turbulence in the entire plasma volume in TJ-I and Wendelstein 7-AS, using microwave reflectrometry.



Electrode and Langmuir probe using method of TJ-1 fluctuation.

Plasma-wall Interaction: In the area of transport studies in TJ-I, we measured the radial profiles of  $H_\alpha$  emission, in a given transverse poloidal section, for different values of electron density and toroidal field, determining the time of confinement of the particles, in order to establish the possible correlation between the deposition profile of particles and their confinement. In the field of conditioning of the vacuum chamber walls, we have done studies of the chemistry and physics of the deposition process, utilizing different types of cleaning discharges, which have permitted us to estimate the efficiency of the initial conditioning of the walls, of carbonization, of carbon extraction, and of the interaction of the plasma --and especially He containing plasma -- and the walls. We have improved the fluorescence optical diagnostic system induced by lasers, which is of great importance to these studies.

Confinement of Particles and Energy: We studied the dependence of energy and time of confinement of the coupled

electrons in TJ-I, in respect to a group of plasma parameters,  $N_e$ ,  $T_e$ ,  $Z_{eff}$  and  $E$ . We deduced an expression, which permits us to obtain the confinement time, as a function of these parameters. We tomographically studied current disturbance, starting with the local values of emission of soft X-rays, in order to determine the poloidal structure of perturbation, which precedes the disruptive instabilities. We also studied the electron energy transport in the plasma of the TJ-I, through stationary analysis of the potential balance, and through the study of propagation of the perturbation, which precedes the disruptive instability. We studied the electron energy transport in the plasma of the TJ-I through the stationary analysis of balance of power and the study of propagation of perturbation, deducing the values of  $X_c$  in both cases.

**Diagnostic System Development:** We continued the reflectometric measurements, which were started in TJ-I and Wendelstein 7-AS (W-7AS), in collaboration with IPP and JET. During 1991 the activities in TJ-I were focused on measuring the fluctuation correlation length of the plasma density, utilizing the method of slow sweeping of frequency. We installed and operated a wide band heterodyne reflectometer in the stellarator, W-7AS for the study of density fluctuations and rapid determination of density profiles. The results were identical with those, obtained in the homodyne detector. We designed an amplitude modulated reflectometric system for the divertor of JET, which allows density profile measurements.

We designed and constructed a 10 channel bolometer, which was installed in a lateral port in the TJ-I. It allows control of all transverse sections of the plasma. Each detector has its own collimator and the network of systems is partially removable for modification of spatial

resolution in the center of the plasma. We designed and constructed also all electronics necessary for its function.

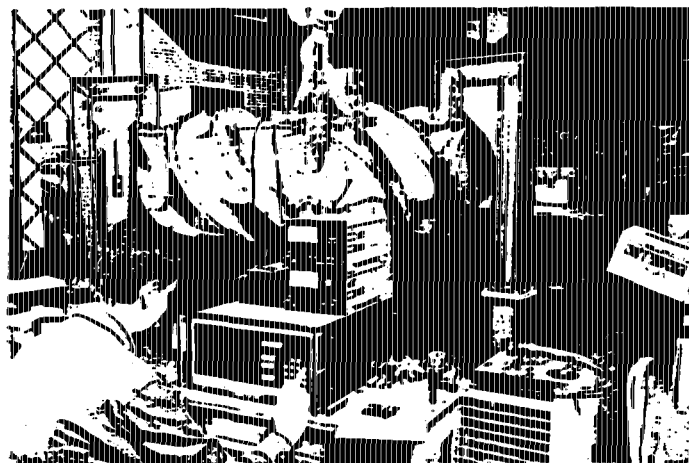
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We improved the capability of the bolometric system for UV in vacuum, based on the phosphorus fluorescence, with the objective of developing bolometry with spatial resolution, and to serve as support of the injection of impurities, via laser evaporation. The group of filters permits the determination of radiation profiles and the selection of predetermined bands.

#### DESIGN AND CONSTRUCTION OF THORSATRON TJ-I-U

The principal activities, related to the construction of this equipment are:

Vacuum Chamber: We welded all ports in the vacuum chamber. We mechanized the contact surface between the support structure of the helical coil and the carrier. We welded the support of the helical coil to the vacuum chamber, thus controlling the magnetic permeability at the weld joints during the entire process. We cleaned the chamber interior by sandblasting the weldments and cleaned the inside walls with organic solvents. We finally tested the vacuum integrity.



Vacuum tests of the vacuum chamber of Thorsatron TJ-I-U

Helical Coil: We tested the electrical and mechanical characteristics of the conductor, selected for the coil construction, and have done impregnation tests, in order to check the ionization of the chosen resin.

Support Structure: We received the support structure, which was constructed in the country, according to a design, submitted by CIEMAT. It is fixed to the floor of the vessel with anchors. This structure holds in position the vacuum chamber and the entire system of coils, allowing an easy access to the ports, which support the diagnostics, and also allows final adjustment of the coils' position, in order to minimize the isometrics in the plasma field. Finally, the vacuum chamber is placed in position on the support structure.

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Design and Construction of Scientific Instruments: We designed and constructed various scientific instruments for the determination of surface magnetism of TJ-I-U. This equipment consists of an electron gun, which can be a manipulator, which permits the emitting of an electron beam at any point of the poloidal section. We also designed three electron beam detection systems, two of which are based on fluorescence measurements, and the third one is a capacitive probe. We designed, in collaboration with the Directorate of Technology at CIEMAT, an acquisition system for images.

We constructed a vacuum chamber with the same ID as TJ-I-U with the purpose of testing the systems to be used in the thorsatron, and especially the functioning of the electron gun.

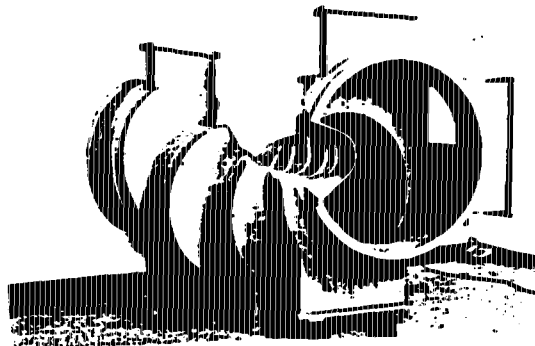


We initiated the conceptual design of a heating system for ion injection at cyclotronic frequency (ICRH) for the TJ-I-U. This is done in collaboration with the Institute of Physics and Technology at Yarkov, Ukraine, after determining the basic parameters of the system and its components.

#### DESIGN AND CONSTRUCTION OF FLEXIBLE HELIAC TJ-II

##### a.) Engineering

During 1991 the main activities of the Engineering Group were focused on the preparation of technical specifications for soliciting offers for the construction of the vacuum chamber, the central helical coils (hard core), toroidal coils and the support structure. The solicitation of offers was completed during 1991, after the contract for construction of the vacuum chamber, and the coils systems were awarded. We followed up the construction of the vacuum chamber and coil systems through the year. The vacuum chamber's final design is a structure of helicoidal grove, for the accommodation of the central helical coil system. It (the vacuum system) consists of 32 sectors and distributor rings, spaced at 4 symmetrical distances. It has 92 ports of different size, which are used for access to the diagnostic equipment. It is constructed of stainless steel and will take 28 months to complete.



Model of a section of the vacuum chamber of heliac TJ-II

The system of toroidal coils consists of 32 circular coils, distributed in vertical planes with quadruple symmetry. Four of the coils are slightly larger, in order to permit access for the neutron injections during heating of the plasma. These are internally cooled and are constructed in two halves, for ease of assembly around the chamber. The construction period is also 28 months.

We defined, in collaboration with the industry, the characteristics for the principal system for power storage. It will consist of a horizontal axis generator of 120 MVA. The inertia of the rotor will supply 100 MJ, by varying its velocity from 100% to 80% for 2 seconds.

#### b.) Heating Systems

During 1991 the activities in this field were concentrated on heating by radio-frequency and resonance frequency injection of: electrons (ECHR), and ions (ICRH) and the injection of neutrons (NBI.)

Heating ECRH: It is based on the utilization of 200 kW of power, provided by a 1 gyrotron at 28 GHz for the plasma creation and heating of the first harmonics, and 2 gyrotron at 53.2 GHz for heating the plasma in the second harmonics. We constructed the RF generator at 28 GHz, including the modulator of the transmission line, the refrigeration system and the magnetic source. The main power source is in construction and consists of 3 gyrotrons. We hope that the entire system can be assembled during 1992 and it will be tested at TH-I-U. We also calculated the transmission line at 53.2 GHz.

Heating by injection of neutrons (NBI): As a result of the studies in this field, we prepared a proposal to Euratom for solicitation of support for the construction of a heating system (NBI) of 2 mW for the TJ-II. The system consists of two tangential hydrogen injectors of 1 mW each at 27 KeV. The technical feasibility studies were focused on two basic aspects: transmission properties through the ports of TJ-II and thermal charges in the vacuum, due to charges in the vacuum chamber. For the latter we will use the corresponding protection screens.

Heating ICRH: We initiated exploratory studies on this heating system, which will be installed first in the TJ-II. With that purpose we established cooperation with CIEMAT and the Institute of Physics and Technology of Yarkov, Ukraine, for the development of the conceptual design of the system.

#### THEORY.

We continued the research, initiated in the years passed: magneto-hydrodynamics, turbulences, kinetic theory and transport, and optimization of the neutron injection.

##### a.) Study of magnetohydrodynamics (MHD)

We completed the comparison of the tri-dimensional codes for VMEC and PIES calculation for determination of equilibrium properties in the stellarator. Although in the first one we postulate the existence of well defined magnetic surfaces, it is possible that in the second we will tackle configurations with magnetic islands and estochastic regions. The correlation of the calculations has been excellent. We completed study on magnetic islands in TJ-II through a code PIES. We studied the effect of the aspect

ratio of the stability limits in a stellarator of the TJ-II type, finding that in increasing of the aspect ratio, the toroidal displacement decreases, but with no effect on the helicoidal. The results have been utilized to establish the stability criteria of Mercier. We analyzed the influence of the ballooning models on the limits of beta in TJ-II, and the value of the magnetic well and current ratio in the coils on the Mercier stability. We deduced a stability criteria for the localized disturbances in the thorsatron and studied its possible development for use in heliacs. Finally we analyzed the stability properties of high iota for different configurations of TJ-II.

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#### b.) Kinetic Studies

We developed a quasi-linear theory of heating of dissipated plasma heating via radio-frequency, which shows that fluxes of particles and heat can be obtained directly from the radio-frequency area. We completed a model of the electron distribution in the case of cyclotronic emission, with the object to derive a group of parameters, which represent the experimental emission and vice versa. The results from this modeling were applied with success to the W-7AS by the Plasma Physics Institute Max-Planck. Finally we developed a method for calculating induced current by cyclotronic waves., without having to solve the Fokker-Plank equation. This method is rapid enough to be included in the code for measuring beams and keeping track of all aspects of the problem.

#### c.) Transport Studies.

We conducted analysis of particle and energy transport in TJ-I, with the objective of finding a general rule, capable of describing the transport in any type of discharge for

values much different than the density, current and magnetic field. The results, obtained so far, show that it is possible to describe the particle flux and the energy through a simple expression, valid for a group of parameters of the discharge and also to give an interpretation of the origin and level of the fluctuations, and also to estimate the value of poloidal propagation velocity.

#### d.) Studies of Propagation of Neutron Injections.

We evaluated the optimization process for deposition of energy in the plasma, through neutron injections in the heliac TJ-II, utilizing code RAFNER/FASOLT, which is an adoption of the tri-dimensional Monte Carlo, to the peculiar geometries, the vacuum chamber and magnetic surfaces of TJ-II. In the simulations we considered using neutrons of 1 MgW and 27 KeV. This code was used also in combination with the one-dimensional transport code (PLASMATOR) for establishing the group of almost consistent temperature profiles and plasma densities, and increase in the density at 200 m per injection.

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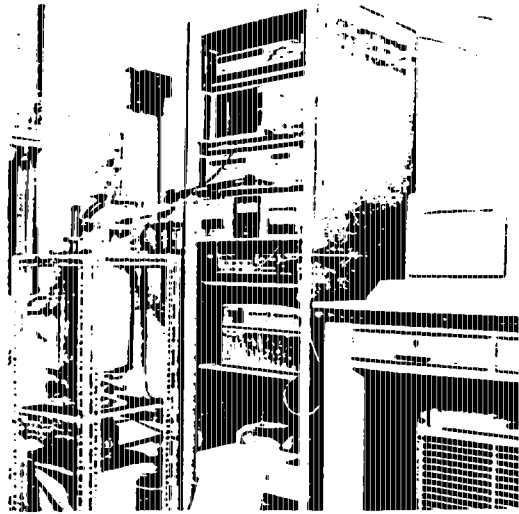
#### Fusion Materials

During 1991, as during the years past, we continued the study of insulating materials, candidates for use in fusion, according to the direction of project PPMA, of the Technological program of NET. The completed work was used to direct the study of behavior of insulating materials under fusion simulating conditions, and toward the characterization and development of materials, appropriate for radio-frequency transmission systems. The activities included studies of the electrical properties during irradiation, and measurements of the dielectric properties before and after the irradiation.

Electric properties: We extended the study of the induced, or intensified, electric degradation, due to irradiation in  $\text{Al}_2\text{O}_3$  in the radio-frequency region between 33 and 126 MHz, after we observed a severe degradation in electric conductivity, which is practically independent of the frequency, which causes serious problems in the use of these insulators in the system of auxiliary ICRH and LH heating . We demonstrated that the indicated degradation phenomena is similar to that encountered in the production of colloids.

Dielectric Properties: We continued the work on the dependency of the dielectric properties of the oxides, considered suitable for utilization in radio-frequency transmission systems, on the temperature. In collaboration with the Kernforschungszentrum, of Karlsruhe, Germany we made measurements at 100GHz in mono and poly-crystal  $\text{Al}_2\text{O}_3$ , observing that the high purity samples exhibit a decrease in their loss tangent, with the temperature. We found high purity, reinforced with zirconium, alumina, which was developed in collaboration with CERATEN. The high purity samples showed dielectric and mechanical properties, comparable to sapphire -- for the first time in a commercial product. We measured the loss tangent for alumina and silicon spinels.

In addition to these activities we completed studies of diffusion intensified by irradiation of hydrogen and deuterium diffusion, effects of the field over the basic radiation design process, displacement threshold, effect of impurities on the loss of dielectric properties and development of multi-phase materials.



Systems for measuring dielectric losses at low temperature for insulation materials.

#### EXPERIMENTAL PARTICLE PHYSICS

During 1991, as in previous years, the activities in the area of Experimental Particle Physics were developed within the context of the National program of High Energy Physics, integrated in the National plan of Scientific Research and Technical development. These activities require International collaboration and are based on the wide use of accelerators, laboratories, installations and services of CERN.

In 1991 the research program of the unit for Particle physics was structured as follow:

- Participation in the experimental program of Collision Rings of Electrons and Positrons LEP (Large Electron Positron Machine.)

- Participation in the Experimental program of Collision Rings of Protons and Antiprotons SPPS (Super Proton Synchrotron) with detector UA1
- Participation in the experimental program of Ultra-relativistic Ions of the Super Proton Synchrotron SPS, with the detector EHS (European Hybrid Spectrometer) and with the detector Omega.
- Participation in the RD-5 project of the Research and Development program of for detectors in LHC.

As a continuation we present a resume of the completed activities in each of these projects:

#### Physics of Electron-Positron Collisions.

This activities represents the fundamental component of the program of the unit and to it has been dedicated a major part of the human and material resources. With the examples, collected in 1990, of hadronic events and leptonic disintegration of ...boson...  $Z^0$ , we conducted the following studies:

- Determination of the strong coupling constant  $\alpha_s$ , beginning with the hadronic disintegration of  $Z^0$ .
- Measurements of the electro-weak parameters (mass, width, and vectorial and axial coupling constants, utilizing the reactions  $e^+e^- \rightarrow \text{had.}$ ,  $e^+e^- \rightarrow e^-e^+e^-e^- \rightarrow \mu^-\mu^+\gamma e^-e^- \rightarrow \tau^-\tau^+$  in the interval  $88.2 < \sqrt{s} < 94.2$  GeV.

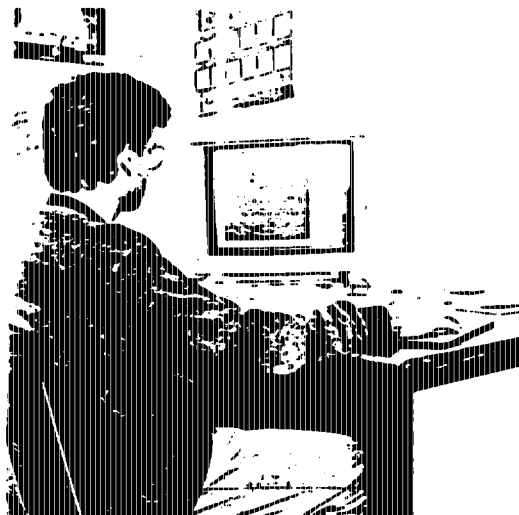


- Search for the ...boson... of Higgs, neutral of the Standard model, produced by disintegration of Z, during the process  $e^+e^- \rightarrow Z^0 \rightarrow H^0 Z^0$ . The analysis allows to exclude the existence of the boson of Higgs in the mass range 0-41.8 GeV, with a 95% level of confidence.
- Measurements of the disintegration properties of  $Z^0 \rightarrow b\bar{b}$ , using events including muons and electrons, after the determination of the value of the width  $\Gamma_{bb}$ .
- Test of QCD based on the study of 43,000 events of 3 jets, originating from the disintegration of  $Z^0$ .
- Determination of the disintegration relation of lepton  $\tau$  in one and three charged particles and of medium life ( $\tau_\tau$ ) of lepton  $\tau$ .

- Search of violation of leptonic orders in the disintegration of  $Z^0$  in leptonic pairs,  $Z^0 \rightarrow \mu\tau$ ,  $Z^0 \rightarrow e\mu$  .

- Determination of number of families of light neutrinos, beginning with the success cross section of one photon produced in collision  $e^+ e^-$  in the region of  $Z^0$  boson.

In April 1991, we renewed the function of LEP, which continued until the middle of November. With the samples we initiated a re-analysis of the test done previously. In this activity the groups for analysis work with the data obtained in 1990-1991 and have also initiated the following projects:



Apollo Systems for analysis of success in L3 detector of LEP.

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- Study of the cross sections of hadronic and di-leptic channels. Measurements of symmetry of the di-leptic channels. Determination of parameters of  $Z^0$ . Obtaining new mass data for the quark top.

- Measurement of the properties of lepton  $\tau$ .

- Determination of the properties of the quark b.

- Search of the Higg's boson ( $h^0$ ,  $a^0$ ,  $H^-$ ,  $H^+$ ) of the minimum super-symmetric extension of the Standard Model.
- Determination of the strong coupling constant  $\alpha_s$ .
- Study of the properties of "jets" of quarks and gluones.
- Study of the radioactive processes in the production of quarks in the final stage of disintegration of  $Z^0$ .
- Study of the production of photons.
- Determination of new mass data of super-symmetric lepto-quarks, heavy leptons etc.

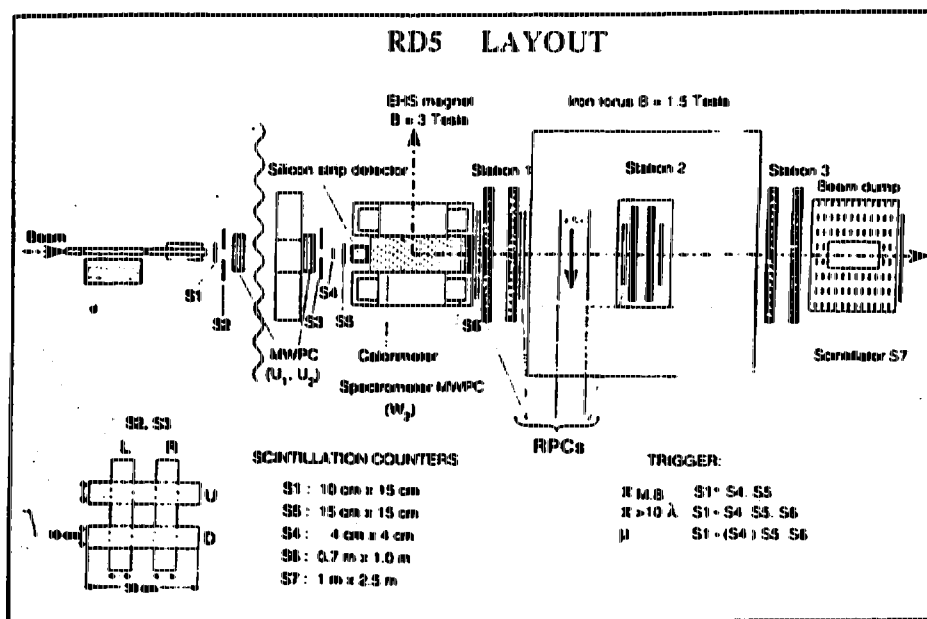
The Unit of Particle Physics has participated actively in some of these analysis, underlining in particular its contribution in the determination of the electro-weak parameters of the  $Z$  boson, and the measurements of the properties of heavy quarks and the study of leptons tau. A significant part of this work was completed at CIEMAT. The Unit of Particle Physics also contributed in the data gathering, using detector L3 and has assured the direct functioning of the muon spectrometer and other detection systems of L3.

With the object to stay competitive, for the continuation of the LEP program (in the area of  $Z^0$  and in the phase of LEP 200) the Joint Effort L3 approved a program for the remodeling of the L3 detector, which includes, among other measures, the construction of a detector of muones, called "forward-backward detector", in which the Unit of Particle Physics has an intention to participate.

## Physics of Proton-Antiproton Collisions.

This activity, initiated in 1986, has permitted the acquisition of an advanced experience in the field of hadronic collisions, making CIEMAT the only Spanish center, collaborating in the project SPPS of CERN. We are responsible for the design and construction of the Uranium and Tetra-methyl-pentane calorimeters (U/TMP) for the small angle regions.

During 1991, we concluded the analysis of the data obtained in the experiments, done with number of electron, muons and pions, with diverse calorimetric modules, constructed to date (3 of the VFW, 2 of the FW, and 4 of the Super Gondola types.) The continued studies of the acquired data has allowed us to strengthen the knowledge in the response of these detection systems. In particular, we have researched the compensation phenomena, and its dependance on the voltage, the energy resolution, stability, etc. With these results we have published several articles.



Layout of detector RD-5, installed in the collider LEP of CERN.

In 1991, the Joint Effort UA1, completed the analysis of the accumulated data through 1988-1989. In continuation we will sum up the most important results, obtained in the analysis of the data.

- Publication of the results by the calorimetric modules of U/TMP, which includes the measurements of electro-magnetic and hadronic energy resolution, in the interval 7-70 GeV, and the relation between the electron and pion responses as function of the energy and the electric field.

- Analysis of the data of the efficiency of the free ions, produced by the radiolysis in hot liquid, within context of Onsager's theory.

- Calculating the value of  $\Gamma_{\nu}^{\text{tot}}$ , starting from a statistical model of 4.66 pb<sup>-1</sup> of  $W^{\pm}$  and  $Z^0$ , produced at  $\sqrt{s}=0.63$  TeV.

- Measurements of the production of quarks  $b$ , and hadrons  $B$ , in collisions  $pp$  at  $\sqrt{s}=630$ -GeV.

- Measurements of the "mixing" parameter  $\chi$ , utilizing the sample of dimuonic events, obtained during 1988-1989 and 1984 and 1985.

#### Physics of Collisions of Ultra-relativistic Ions.

This activity, whose scientific motivation is in the search of quarks and gluons in the plasma (Joint effort NA36), concluded in 1990, the data acquisition phase in 1990. The analysis was partially completed in 1991, and will be finished in 1992. Now we proceed with the analysis of the data of fragmentation via protons and  $^{32}_S$  in Al, Cu and Pb,

and the determination of the efficiency of the charge change between  $\Delta(Z)=1$  and  $\Delta(Z)=4$ .

The developed activities, in relation to the experiment NA36 have been:

- We completed the analysis of the data obtained in 1987, which produced results which were quite strange, as compared with those predicted by the Monte Carlo program. These did not reveal the existence of a threshold, related to the centrality of the interaction.

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- The production process and data analysis of the data obtained in 1990 is in an advanced stage of development. We obtained results from the interactions S - Pb at 200 GeV/c per nucleon.

- We completed the calculations of the cross sections of fragmentation S - Pb and S - Cu at 200 AGeV/c, for data taken in 1990.

We initiated our participation in the WA94 Experiment (Study of Baryon and Anti-Baryon Spectra in Sulphur Sulphur interaction at 200 GeV/c per nucleon.) The activities of CIEMAT, as related to this experiment consist of:

- Construction in the general Workshops of CIEMAT of a Cerenkov detector, of the threshold type 1 m long and with a unique cell, for work with gaseous radiators, and designed for spectrometer WA94, where the secondary particles arrive with values of  $p \leq 5$  GeV/c and high p. Its function is to cancel the contamination electrons. This "Cerenkov Veto" instrument will be used for data acquisition in 1992.

- Participation in the data collection of WA94 (October-November 1991) of interactions  $S - S$  at 200 AGeV/c. Its objective is to complete the measurements of production of strange particles and to compare these with the results, obtained with WA985 for the interactions  $s - W$  and  $p - p$ .

#### Research and Development of LHC

Within the goals of the I+D Program, approved by CERN, with the object of preparation of LHC experiments (Large Hydron Collider), the unit of Particle Physics participated in the preparation of the research and development RD-5. The RD-5 project is an experiment, which has as an object the study of muon "triggers" and the reconstruction of its pulse in an intensive magnetic field. We are planning to make a proposal for a new detector LHC. The RD-5 project is associated with the design of a complete detector for the LHC, named CMS "Compact Muon Solenoid".

In the beginning of 1991, we initiated the remodeling of the zone EHS, and in August we completed the installation of a new experimental device, thus initiating the data collection of pions and muons in the interval of 20-30 GeV/c. The contribution of the Unit to this phase of the project, consists in the participation of the start-up of the experimental device, of "software off-line" (express line) and of the programs of pre-analysis and participation in the data collection process.

In relation to the project RD-5, we participated in the analysis of the data, obtained in August-September, and the design and construction of the chamber prototype PPC, parallel plate chamber in CERN, in collaboration with ITEP and CERN, for the simulation, design and preliminary tests for the construction of a calorimeter for detection of small

angle particles for CNS and in the development of a prototype of an event builder for LHC.

## Instrumentation

During 1991, this section continued the development of research projects for the design of new data acquisition systems, configuration and transmission of data for high luminescence experiments. Now we are fabricating a prototype of a competitive modular and parallel "event builder", for management of transmission of  $10^{10}$  bytes/sec., which is expected in the experimental process of LHC. Also we participate in the construction of the Cerenkov detector, for work with gaseous radiator, related to the experiment WA94. Also we participate in the conceptual study of the particle accelerator, known as "Tau factory", which can be located in Spain.

## RADIATION PHYSICS

### Metrology of the Ionized Radiations

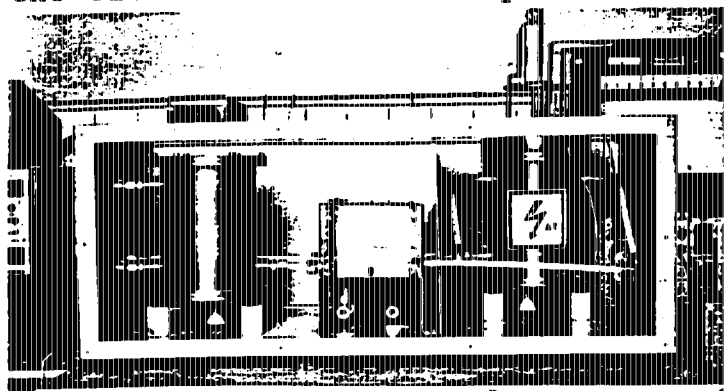
We continued the development of the work initiated in previous years. These were: improve the characterization of nuclear parameters and establish adequate methods of detection of the radiation, maintain the international traceability of the references for measuring radioactivity of Alpha and Beta-Gamma emitters, establish, maintain and disseminate the units of exposure, kerma, absorbed dosages and the derivatives of these, in order to obtain the needed precision and uniformity of the measurements at this magnitude and to develop solid state techniques, applicable to the dosimetry of ionized radiations. Below we present the main results, obtained in this area:

#### a.) Calibration of Radio-nuclides Alpha Emitters.

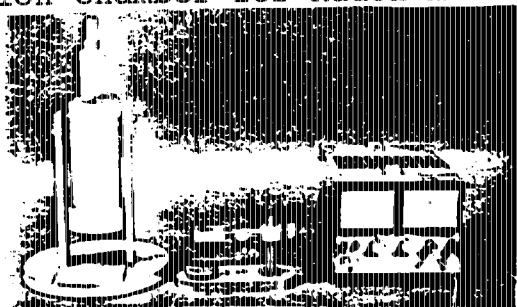
We continued the collaboration with the Central Bureau for Nuclear Measurements for the determination of the possibility of Alpha emission of different nuclei, after we finished the analysis of the corresponding data of Pu-235 and Am 234.



We designed and constructed a chamber for absolute measurements of Radon and all the electronics for its operation.



Ionization chamber for Radon measurements



System of units for electropolymerization and ultrafine, conducting pyrrolic films.

We completed a study on the corrections of retro-dispersion and auto absorption in Alpha particle media, with ionization chambers  $2\pi$ , and low geometry detectors, through Monte Carlo simulation. The correlation with experimental measurements was excellent.

We initiated a research project in collaboration with the University of Extremadura, destined to the determination of the influence of the Uranium mines, in the Badajoz province.

We utilized various radiochemical procedures for the characterization of the oxidation state of trans-uranium elements, and Pu solution in particular.

We continued the study of the procedures of concentration in-situ, of very low concentrations of Alpha emitters in water, utilizing  $\text{MnO}_2$  and  $\text{Al}_2\text{O}_3$  cartridges.

In collaboration with the Institute of Nuclear Technology, we developed a method for determination of Pu, Am, Cm in ion exchange resins, originating from nuclear stations.

We prepared, and calibrated, solid radioactive sources, and also calibrated solutions of different Alpha emitters for the utilization as references, or tracers, within and outside of CIEMAT.

#### b.) Beta-Gamma Metrology

We developed a procedure for preparation of ultrafine conductor films by electro-polymerization of pure or mixed with VINS Pyrol.

We prepared and calibrated organic and inorganic samples Mn-55, Cd-109, Ca-45 and Co-60, utilizing the CIEMAT/NIST method for testing the stability of compounds, evaluated the efficiency, calibrated the solutions and mixtures of (FI-55) + (H-3) for testing methods of determination of activity of double marked samples.

We modeled the spectral response of liquid scintillators for H-3 and C-14, via Monte Carlo simulation in collaboration with UNED) and through a semi-analytical formulation (in collaboration with the University of Barcelona), which describe the Beat emission processes, interaction with the scintillation, production of photoelectrons etc. The correlation between both models is excellent.

We designed, in collaboration with Polytechnic University of Valencia, a prototype of a counter, which operates on the principle of the relation between double and triple coincidences. It has a character of an absolute instrument.

We continued, in collaboration with the University of Barcelona, a theoretical and experimental study of the detection efficiency of silicon detectors of the implanted type for detection of electrons with energy in the 20 and 150 KeV range.

We revised the codes for efficiency of Beta emitters and electron capture with the object of extending the validity and composition of the commercial type DIN scintillators. We participated in an International interchange of information on C-14 and Tc-99 in liquid scintillators calibrating 35 samples of this radionuclides.

Finally, we organized the International Conference ICRM '91, through a symposium on "radionuclids Metrology and its Applications", which took place in the CIEMAT installations from 25 through 31 of March.

#### c.) Radiology

We continued the effort of elevating the metrology level of the doses, absorbed in water of the energy, Co-60, marking the axis over a water sample. In relation to the Primary X-Ray Laboratory, we arranged the mechanical and electric elements, designed for adaptation in a new generator at the installation.

We continued with the verification of stability of different reference chambers of the Unit. The Spanish reference Standard of energy Co-60 on therapeutic levels, consists of three chambers of the Shonka type. It was re-calibrated in June at the Laboratory of the International Office of Weights and Measures (BIPM.) We also verified the equipment for safety levels, which was re-calibrated this year at the National Physical Laboratory (NPL) and the radio-diagnostic equipment. Finally, we incorporated a monthly mechanical safety and annual dosimetry verification, as provided by the Plan for Calibration for the Laboratory for Gamma Safety Levels.

The fifteen Spanish participants in the European Conference of radio-diagnostics equipment were informed of the results of the information interchange, which includes calibration factors of the chambers and their energy response curves. The comparison of these factors with previous information, allowed to evaluate the measurement errors for all chambers. The

results of this interchange was the subject to two communications and one CIEMAT report.

In relation to the dissemination of units, we calibrated in six ISO quality levels the chamber NE2575, of the Institute of Energy Technology (INTE) with the CIEMAT standard, which consists of an analog chamber, calibrated at the National Physical Laboratory. For this we used the installation and quality ISO standards of INTE.

Within the activities of the Laboratory Gamma Safety Levels, we calibrated 220 pcs. of equipment, of which 7 are a part of the reference equipment of three nuclear stations. We made 1, 353 controlled irradiations and inspected 34 X-ray pieces of equipment, dedicated to research. During all these activities at this Laboratory we issue 245 certificates.

#### d.) Dosimetric methods

We continued the activities of research and characterization of new thermoluminescence TL materials. These activities were developed in collaboration with the Department of Physics of the University of Rome, after completing a study on the isothermic di-excitation of LiF Mg Cu P.

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In collaboration with the Department of Health Physics of the National Laboratory RISO, Denmark, we developed a new procedure for analysis of TL signals, produced in non-linear heaters. We completed the program for automatic analysis of such signals.

During 1991, the Unit of Dosimetric Methods at CIEMAT in collaboration with the inter-faculty reactor of the Laboratory of the University of Delft, Holland, was busy with the organization of the 1st International Interchange of Numerical Analytical Methods for Thermo-luminescent Curves "GLOCANIN", which was held during the first semester of 1992. This collaboration was extended to other activities, such as the application of analytical procedures to TL materials, developed independently by both groups. We

continue with the development of a program for specific program for study of new TL materials, and especially LiF, Mg, Cu P, a material, which can be used for low dose measurements.

We continued with the research project "Postal Dosimetry in Radio-therapy", financed, partially, by the Health Research Fund. We made important advances in developing a postal system, based on numeric analysis of TL curves of LiF TLD-100, and started the study for use of LiF Mg Cu P for this type of application.

Together with the environmental Institute of CIEMAT we continued work on project CEE "Measurement of Environmental Gamma Doze Rates" in collaboration with groups from the National Laboratory RISO, Denmark and Physikalish-Technische Bundesanstalt, Germany. We have to point to the work completed in the salt mine Asse, Germany, using Gamma ultra low doses of ambient Gamma radiation.

We completed the characterization work in the evolution of the TL peak in LiF TLD-100 in the interval of ambient temperature between -10 to 70°C.

#### NUCLEAR AND LASER PHYSICS

We continue the research initiated previously for determination of atomic and molecular constants, studies of basic excitation and ionization processes by particle impact, the development of emission spectrometry techniques for plasmas produced by laser and the development of applications for lasers and scientific instruments. The results follow:

We obtained the spectra of Ni and Cr at wavelengths of 2,000-5,000Å, utilizing a hollow cathode lamp of these elements, which use Ar or Ne as fill gas, with the object of comparing them with the corresponding spectra, as measured in plasmas, produced by laser. We want to determine probabilities of transition to different configurations, compared with calculations, utilizing intermediate coupling.

We calculated the probability of transition lines belonging to the S, P and D series of  $\text{In}(1)$  and  $\text{Tl}(1)$ , obtaining 150 values for transitions, corresponding to  $\text{In}(1)$  and 238 corresponding to  $\text{Tl}(1)$ .

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We determined the probability for transition, relative to the triplets  $4s^3S^o - 2p^4P$  and  $3d^3D - 2p^4P$  of neutral oxygen. We used a hollow cathode  $\text{O}_2$  discharge for light source. We proved that these transition probabilities are in accordance with the expected theoretical relation.

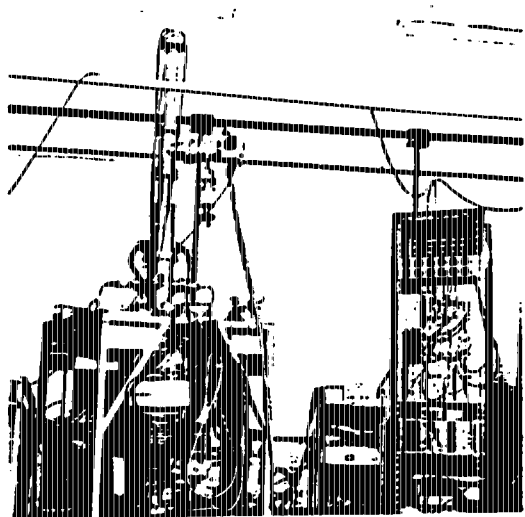
We made a systematic calculation of the Born and Born-Oppenheimer-Ochkur approximations, of the cross sections, at the Ar and Kr levels. The cross sections coincide with the calculated ones, beginning with the Hartree-Fock, which shows the equivalency of both treatments. The obtained results were represented in tables, which represent the cross sections as a function of the incident energy for values up to 1,000eV.

We determined the cross sections of excitation of 254 levels of the configurations n, p, d of He, Ne and Kr and derived feasible value and table rules.

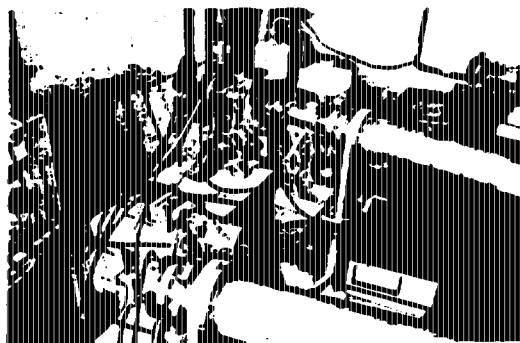
In collaboration with the Dept. of Atomic Physics at UCM, we measured the atomic energy and charge of particles, produced by multi-photon ionization via laser. The separation between the different ions was accomplished by time of flight.

We developed an analytical method for C determination in steel, based on emission spectral analysis, induced by laser Nd:YAG, which impacts on the sample, producing plasma. The light of this effect is collected optically, and is introduced into a monochromator, where the behavior of a predetermined spectral line is measured by a multi-channel optical analyzer. Following this procedure, we made calibration curves, which reflect the percent of C and Fe in the steel. The curve is linear for concentrations of 0 to 2% of C and permits a limit of detection of 50 ppm. This work was done in collaboration with the dept. of Nuclear Physics of UCM, through an agreement. Utilizing the experimental analog method in the section above, we studied the content of Cr

in steel alloys. We obtained a calibration curve of the Cr vs. Fe from .1 to 30%, with a limit of detection better than 50 ppm. The work was done in collaboration with UCM. We calibrated a 3m UV vacuum spectrometer, designed at the Unit and having an ample spectrum of wave lengths, by getting a emission spectrum of neutral and ionized oxygen from 390 to 2,350Å.



Time of flight measurement system.



Detail of the 3m UV vacuum Spectrometer

We calibrated the spectrometer by time of flight method, used at the Institute for the analysis of elements. As a source for photoionization we used a red laser, bombarded by an eximer laser of XeCl. The values for the separation of the mass coincide with the theoretical forecast.

We designed and constructed a multichannel, optical detector of 1,024 photodiodes, for use with a 3m UV vacuum spectrometer. The system has a port for optical fiber use and circuits for control and reading, which produce the necessary impulses to operate with the signal, generated by each photodiode.

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We installed and started a fiber optic transmission system and multichannel detection for the plasma studies of laser produced plasma. We calibrated the experimental wave length system and its operation efficiency now is in the 2,000-6,000A range. We proved the good behavior of the system by obtaining the spectrum corresponding to the formed plasmas in a solid Fe sample.

## RESULTS

As a continuation, we will sum up the results, obtained during 1991 at the Institute of Basic Research, referring to different types of scientific publications, communications, doctoral thesis and signed agreements.

PUBLICATIONS					
	Fusion	Particle Physics	Metro- logy	Atomic Physics	TOTAL
Articles in International Magazines	21	26	5	2	54
Articles in National Magazines		1	--	--	1
Information and Preprints	15	8	11	5	39
CIEMAT Reports		1	1		2
Communications	50	33	17	6	106



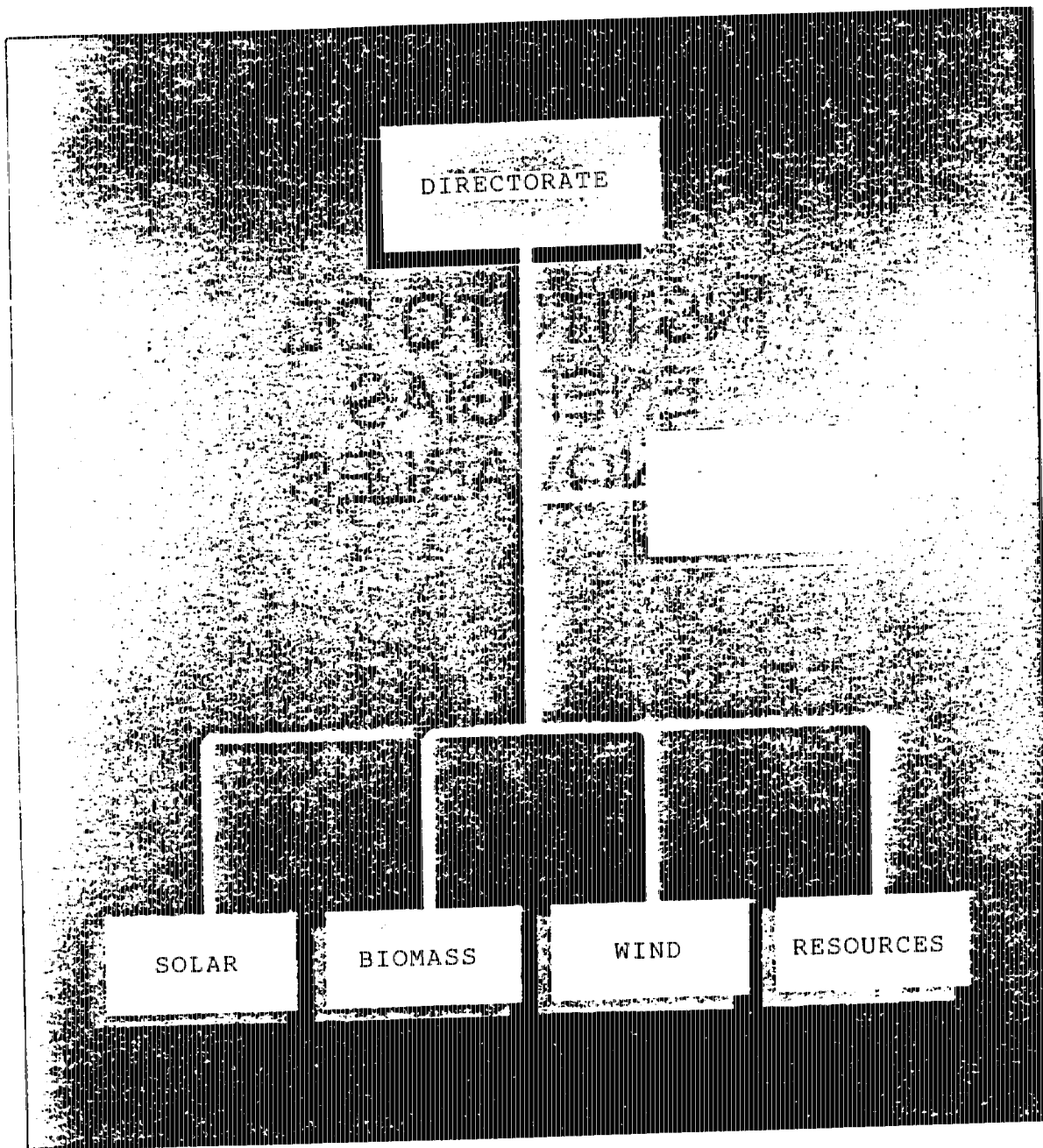
Doctoral Thesis	1	2	---	1	4
Graduation Thesis	---	1	---	---	1
Collaboration in Books	1	1	4	1	7

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AGREEMENTS, SIGNED DURING 1991	ORGANIZATION OR PUBLISHER
Fusion	
o A spectrometer for studies of shapes and fluctuation of intensity in fusion plasma.	CICYT
o Experimental and technical study of the turbulence phenomena in fusion plasma.	CICYT
o Study of equilibrium and stability of TJ-I and TJ-II	UCM
o Bi-demensional model of magneto-hydrodynamic equilibrium of stellerators	UCM
o Construction and installation of a red laser bombarded with a flash light for experiments on laser fluorescence.	UCM
o Plasma-wall interaction phenomena in thermonuclear fusion devices. Measurements of parameters of the plasma edge and the sputtering phenomena via mass spectroscopy.	UCM
o Reactor Hayden project.	OCDE
Particle Physics.	
o Help for organization in Spain of a physics school of CERN	CICYT
o Participation in WA94	CICYT
o Participation in RD-5	CICYT
Metrology	
o Study of the natural radioactive contaminants (RA, Th, U) in continental aquatic media.	CICYT
o International Conference of Radionuclide Metrology (ICRM)	CAM

INSTITUTE  
OF  
RENEWABLE  
ENERGY

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## INSTITUTE OF RENEWABLE ENERGY

The Institute of Renewable Energy has as an objective the completion of research and development projects on technology for using renewable energy.

The areas of emphasis are: solar energy -- passive, thermal and photovoltaic, wind energy, biomass energy, and evaluation of renewable energy resources.

The major part of the projects are referred to the Community Research and Development Program, and especially the program JOULE. So, during 1991, we worked on projects related to these programs and initiated an important effort for making proposals to the JOULE II program.

We must point out the active participation of CIEMAT, through the Institute of Renewable Energy in the European Agency for Renewable Energy in many areas. EUREC Agency is registered as an European Agency for Economic Interests, and reinforces the International character of these activities.

In 1991 we extended up to 1994 the Agreement between Spain-Germany for joint work on the solar plant of Almeria. An important point in this development was the visit of the Minister of Industry, Commerce and Tourism of Spain and the Minister of Research and Development of Germany, to the solar installation. The research and development activities are undertaken in three centers:

Madrid: in CIEMAT's installations in Moncloa, from where the activities of all divisions are coordinated, and where a major part of the research and development activities are done.

Almeria: here is the solar installation (PSA), close to Tabernas, which is a major European Center for application of concentrated solar energy.

Soria: here is the Center for development of renewable energy (CEDER), where we develop the activities of the energy evaluation program from forest resources, and which has significant laboratory and pilot plant equipment.

The Institute of renewable energy is structured into 5 Units, which develop technical activities, assigned in relation to the different renewable energy programs undertaken at the Institute.

#### PERSONNEL DISTRIBUTION<sup>1</sup>

Unit	TS	TM	Aux.	TOTAL
Directorate	1	—	2	3
Support Unit	3	4	13	20
Solar	41	8	58	107
Biomass	18	—	10	28
Wind	6	1	1	8
Resources	4	—	1	5
<b>TOTAL</b>	<b>73</b>	<b>13</b>	<b>85</b>	<b>171</b>

Included is personnel for contracted services, especially for operation and maintenance of the solar installation at Almeria.

The assigned budget at IRE, as a part of the General budget of the State, for 1991, was 486 MPTA investments. This quantity was increased to 117% by external contributions, through the collaborative projects and commercial operations with organizations and entities, outside of CIEMAT.

INVESTMENTS AND EXTERNAL INCOME OBTAINED  
(MPTA), DURING 1991

Unit	Investments	Incomes
P.S.A.	511,3	341,5
Solar	157,6	78,0
Wind	30,7	9,9
Biomass	112,5	53,7
Resources and O.E.	9,5	7,7
Support Unit	17,3	—
<b>TOTAL</b>	<b>838,9</b>	<b>490,8</b>

In this table we have not included the relatives of the personnel totalling 203 MPTA, and other expenses necessary for the operation of the activities of the Center, at 47 MPTA.

## ACTIVITIES DURING 1991

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### SOLAR

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#### Passive Solar Energy

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The principal goal of the Passive Solar Energy group is to develop bioclimatic systems for energy efficient buildings.

During 1991 we finalized the "Study of methods for short term dynamic monitoring of passive solar buildings", in collaboration with the Dept. of Thermal studies at the University of Valencia.

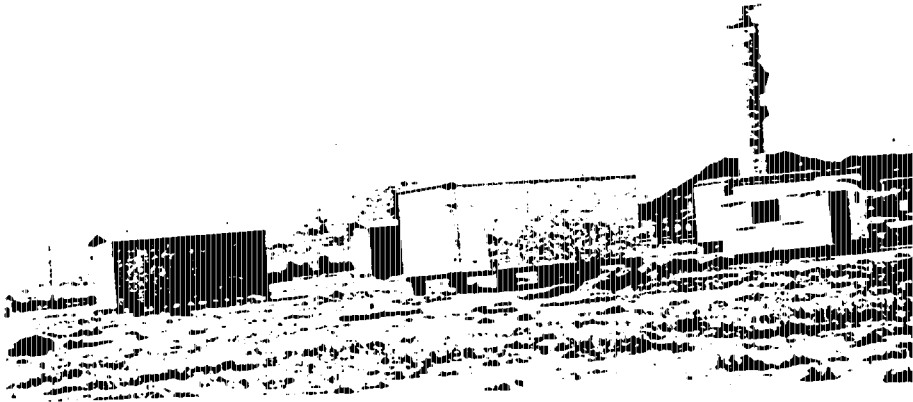
In respect to the project of monitoring, we installed sensors for data acquisition, which will make it possible to understand the energy behavior of the passive solar buildings of Aguilar de Campoo in Valencia. Presently we are testing its function in the summer, in order to understand the building behavior. All this work is done with an agreement signed with the group of Castilla and Leon. We installed sensors and started work on the central school district of Guillena, Seville, per an agreement with the District of Andalusia.

As far as the characterization of passive solar components is concerned, we continued the tests for starting the test modules for testing passive solar components known by the name of CESPA, at the Solar Installation at Almeria.

We continued the project of "Energy analysis of bio-climatic buildings", consistent with the simulation of energy behavior of buildings of the architectural project.

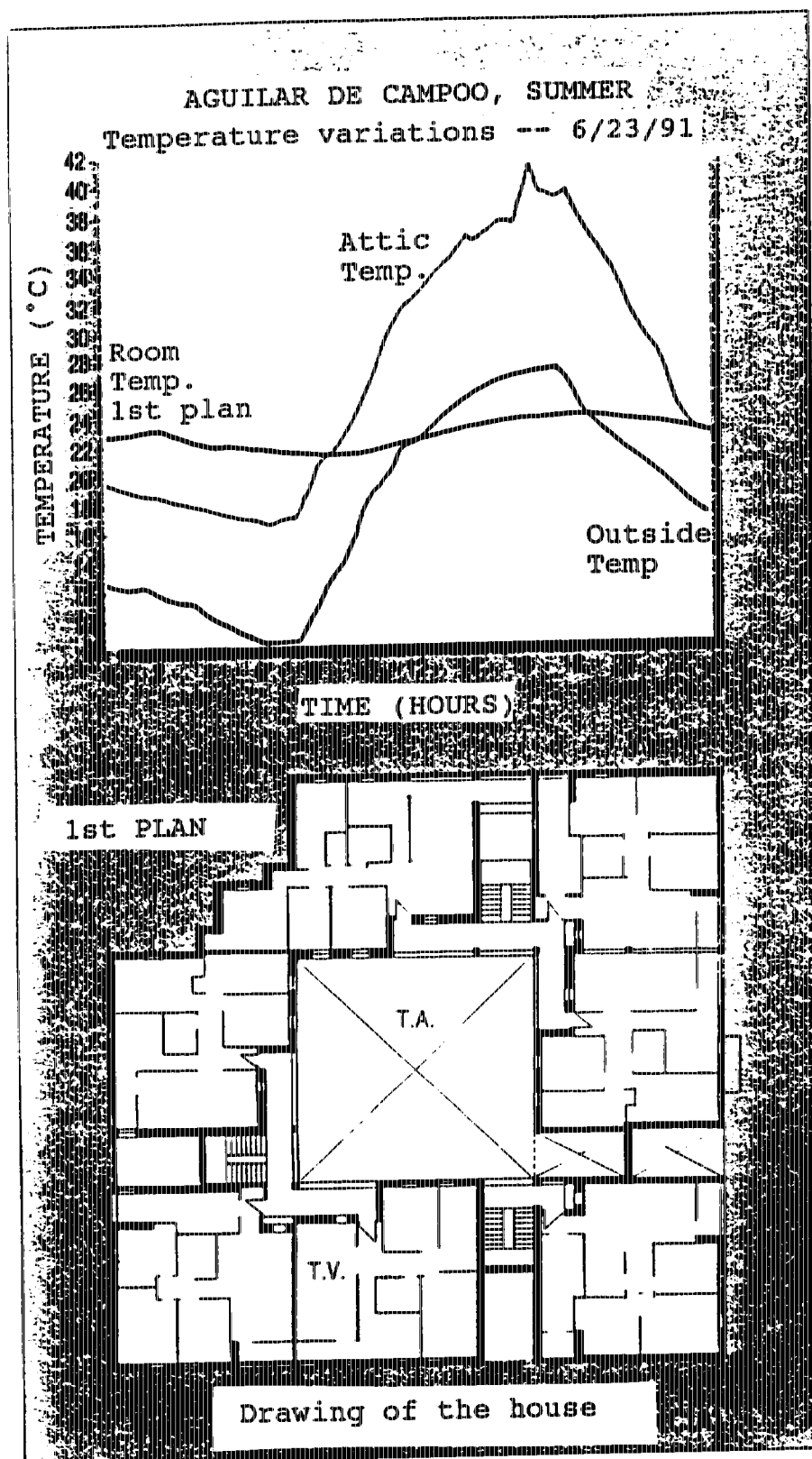
In this project we signed a contract to subsidize as requested in the THERMIE program, the construction of a solar housing block for the public safety project at Pamplona.





General view of the 4 test modules: PASSYS and CESPA.

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Temperature variations during summer inside and on the patio in Aguilar of Campoo project

In the area of International programs, within the JOULE program of the EC in "Applications of solar energy in buildings", we started the research activities as an active member in the second phase of PASSYS II, where CIEMAT is the Spanish representative. In this program we test the passive solar components in all EC countries, using the same test module, and the same instrumentation and methods. We contributed to the following subgroups of this program:

- Validation of development models
- Development of simplified design methods
- Development of Test Methodology and experiment design, making it possible to determine the feasible mode of the physical parameters, characteristic for passive solar components under test.
- Place of the tests, which are under way at the Solar Installation at Almeria together with the test module of the National program CESPAS. During 1991, we started the acquisition and installation of sensors and equipment, start up and calibration of these modules.
- With the International Energy Agency we finalized task 11 "Passive Solar Energy for non-residential buildings". We continued the participation in task 12 "Simulation and calculation methods for passive solar buildings", with validation by comparison of the S3AS method with other methods.

#### Low and Medium Temperature Solar Thermal Energy

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The activities here were related to the project "Solar Thermal Desalination", whose second phase was executed at the Solar Installation at Almeria. We finished the preliminary tests of the absorption heat pump, designed especially for this project. It will permit the residual heat recuperation of 35°C and will increase significantly the efficiency our work. Analyzing the potential of this solar thermal energy application, we prepared a report in which we described the desalination technology, and the solar collectors

adequate for each case, pointing to the possibility for greater potential of development. For this we have prepared different hardware for calculating the thermal, optical and economic factors of the process.

The development activities of new solar collectors were important for the transfer into the Spanish industry of the collectors CPC, as well as test and improvement of a cylindrical parabolic concentrator, which was constructed in collaboration with the industrial enterprise "Abengoa, S.A.".

Within the new lines of materials for absorber covers or transmission in the visible spectrum, and low emission in the IR zone, we performed bibliographic research and some promising tests. The characterization of the solar system beginning with their dynamic response during normal operation is another activity, which has given good results.

This work is coordinated with the activities of the other national and international groups (DLR, CE, AIE).

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#### HIGH TEMPERATURE SOLAR ENERGY. THE SOLAR INSTALLATION AT ALMERIA (PSA)

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The Solar Installation at Almeria consists of the following operating installations:

- Central tower system CESA-1 of 7MW, 300 heliostats, 2 receiver towers of 80m, and a storage system.
- Central tower system CRS of 4 MW, 94 heliostats, and a 40m tower.
- Two collector systems for electric application and industrial processes.
- Solar furnace of very high concentration for chemistry work, metallurgy, or materials development



Solar Furnace

- Solar desalination plant, coupled with a field of collectors.
- Chemical connection with the reactor for recovery of methane, coupled with hot air from CESA-1
- Connection for detoxification of contaminated water
- Four test modules for testing passive solar energy. 2 Spanish (CESPA), and 2 European (PASSYS)

During 1991 we continued the research projects as follow:

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#### 1. Energy generation and system development

We installed three parabolic dishes, with 10 KW Sterling motors for producing electricity, for the German company Schlaich Berghermann and Partner.

#### 2. Development of components: Heliostats and Receivers.

We finalized the construction of a tension membrane heliostat, of 9m in

diameter. We also made 500 facets, for replacing the deteriorated ones on the CESA-1. We tested new designs of absorbers in the 200 KW volumetric receiver "test bed", installed in the CRS tower.

### 3. Thermal Processes.

We finalized the development and installation of an absorption heat pump in the desalination plant, with which we expect to increase the system's yield, with the object to lower the cost per  $\text{m}^3$  of purified water up to 300 pesos/ $\text{m}^3$

### 4. Solar Chemistry

This is a new field in which the concentrated solar energy finds a wide area of application. The evolution of projects of recycling of methane, during 1991, demonstrated the feasibility of this technology to obtain 75%  $\text{H}_2$  gas. For detoxification of the organo-chloric contaminants we utilize photo-catalytic processes with solar energy, applied to a  $350\text{m}^2$  aperture. It demonstrated the degradation of Penta-chloro-phenol and its complete disappearance with time in the presence of  $\text{TiO}_2$  and under concentrated UV for 15 minutes.

### 5. Test of materials for the space launch HERMES

We initiated work this year for adapting the platform situated 54m up on the CESA-1 tower for the test of the "nose". We also initiated work for the design and construction of a model "nose cap" in the shops of CIEMAT.

We finalized the construction of the solar furnace, which was used for treatment of material surfaces, and proved to be a flexible tool for this type of application.

### 6. Courses and Seminars.

During 1991 we developed courses of: Collector systems, Central tower system, Desalination and purification of water, Application of the financial scheme for INEM, Thermal application of solar energy in concentrator systems.

The Community Access and Large Installation program has had a great effect on the PSA's activities. These can be separated as follow:

- Important impulse for the application, development and publication of scientific and technical works, related to the European environmental politics.
- Promotion of scientific knowledge, available at PSA, to other European research centers, and also the stimulation of these relations.
- European point of reference for the technical and scientific transfer of concentrated solar energy applications to other scientific multi-discipline areas.

In particular we have accomplished:

- The modification of the two new installations, used for completion of experiments proposed by customers, for example: detoxification in the solar furnace.
- Development of new measurement techniques of data acquisition systems.
- The installation of a chemical laboratory.

The work done within the four areas, during 1991, is as follow:

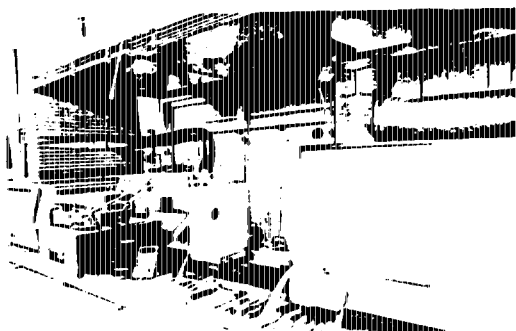
- Treatment of metals
- Solar detoxification
- Development of control system
- Test of ceramic materials in the solar furnace

## Environmental Technology. Solar detoxification

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In 1991 we consolidated the detoxification project, which was started in 1990, beginning with the support from the Plan for Access and Large Installations of the EC, for the creation of a pilot plant for photo-catalytic treatment of effluents at PSA, and also for the creation of a Horizontal program for environmental technology at CIEMAT.

The fundamental objective of the project is the utilization of solar radiation, with special optimization in the UV spectrum, for destruction of organo-chlorides in industrial wastes.



Front view of the installation for solar detoxification in a gaseous phase with the solar simulator shown in the foreground.

During 1991 we developed three lines of activities and sub-projects. Two were financed by the regional plan I+D and by the Community of Madrid "Solar detoxification of effluent liquids" and "Pyrolysis and recycling of industrial waste with solar energy", and the other one was for the EC's "Solar detoxification plan for Access and Large Installations"

In the first sub-project we installed a laboratory, which analyzes different tests of degradation of contaminants, dissolved in water, through the use of a 1,600W solar simulator. We tested the destruction of salycilic acid in water and at present we experiment with the elimination of ethylbenzene in water. This is done with the help of a semiconductor powder dispersed in the solution ( $\text{TiO}_2$ ).



In the second sub-project we use a 4,000W solar simulator with 1,000X concentration, in which different types of catalytic reactions are used, through a quartz window. The destruction takes place in gaseous phase at 300°C. During 1991 we initiated work with a system for test and validation, using methanol and hexane, contained in a carrier gas He.

In the detoxification area at the PSA, we finalized the operational tests, including the response curve of the photo-reactor at different levels of magnification. Also we finalized the test bank for degradation of Penta-chloro-phenol, dissolved in water, which project was done in collaboration with the University of Turin and another company, related to ISFH of Hannover. The work was concentrated in the area of degradation of dichloro-acetic acid.

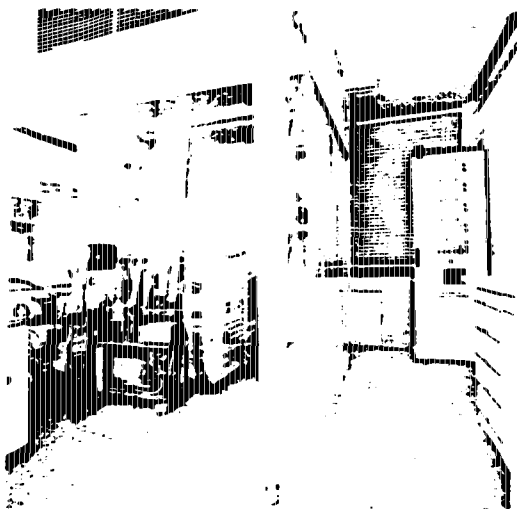
#### Thin Film Solar Cells

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The laboratory for thin film solar cells of IER, has as an objective the preparation of photovoltaic (PV) devices, based on thin film materials and poly-crystalline and amorphous silicon.

During 1991 we participated in four projects. One with EC (OASIS) and three with CICYT. We have developed the following activities:

- Within the OASIS project we measured the optoelectronic characteristics of the "p" types, prepared from ternary mixtures of silane  $\text{SiH}_4$ , methane  $\text{CH}_4$  and Boron trifluoride ( $\text{BF}_3$ ), obtaining thus values of conductivity and gap, adequate for use in p-n devices.
- In the project "Preparation and characterization of p-n semiconductor devices, based on amorphous silicon thin films," CICYT, we installed a gas safety cabinet. We also studied the stability of doped Indium oxide (ITO) and its influence on opto-electronic properties.



View of the laboratory for preparation of amorphous silicon.

- In the project "Preparation of calcogenic poly-crystalline semiconductors". Application of electrochemical methods for characterization of poly-crystalline and amorphous semiconductors", CICYT, we started the use of techniques, which allow determination of the surface photovoltage (SPV), which permits the determination of the depth of diffusion of minority carriers. After that we optimized the optoelectronic properties of the absorbing layers of selenium, copper and Indium ( $\text{CuInSe}_2$ ) and the window layers of ZnO and CdS.

#### Laboratory for PV Modules and Components

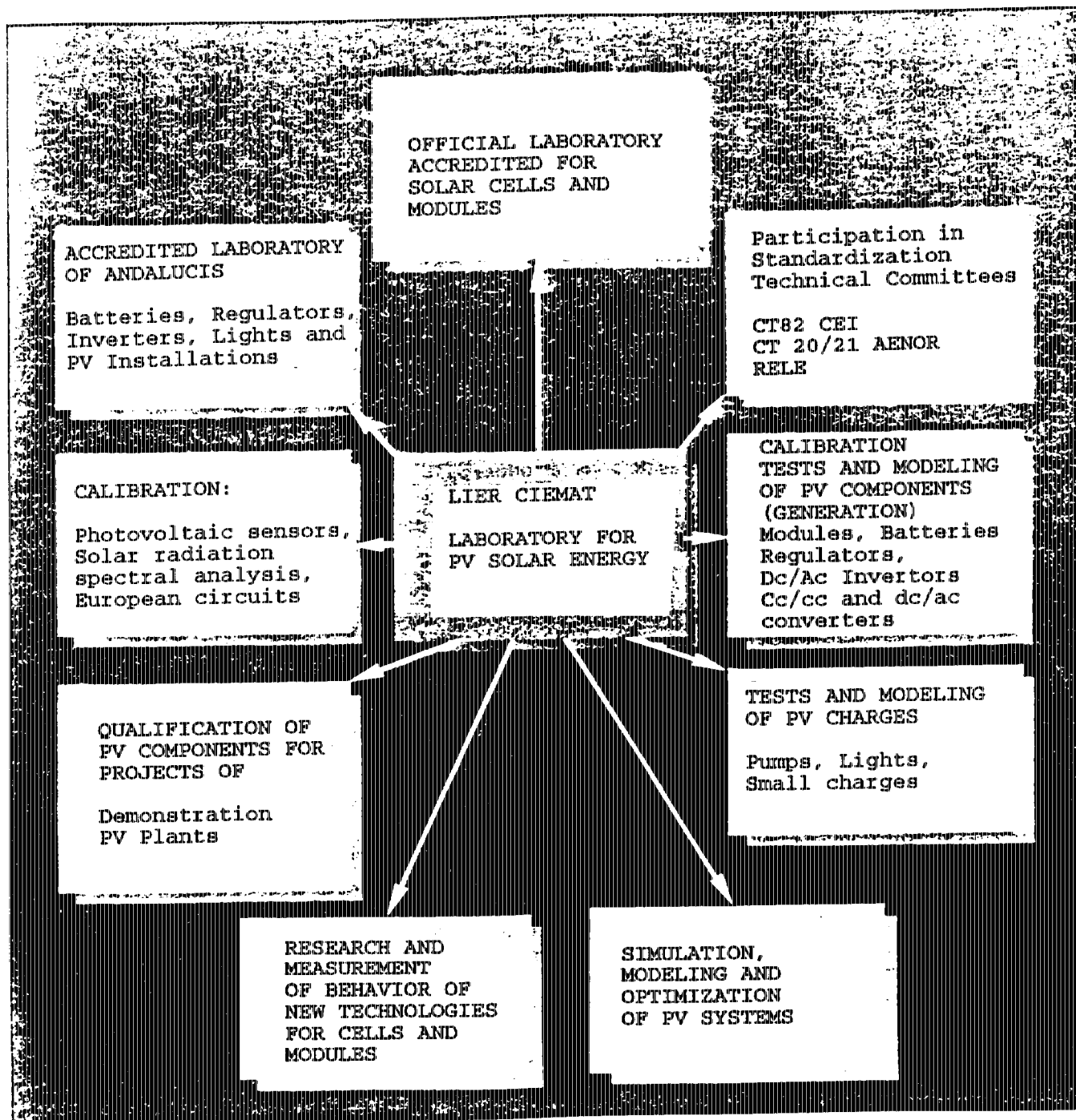
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Its activities are centered on the collaboration in national and international research projects, with the industry, institutions and users for the development and improvement of PV devices. These activities include analysis, characterization, study of the degradation and corrosion of the PV modules and cells. These were made with new technologies, such as amorphous and poly-crystalline thin film silicon, cascade cells, high efficiency cells, etc. We also developed simulation programs for sizing of PV systems and theoretical modeling of PV devices.

We continued the activities as a laboratory, accredited by the Ministry of Industry, Commerce and Tourism for tests and qualification measurements of cells and modules and also a laboratory, accredited by the District of Andalusia for the tests of PV components -- batteries, invertors, lamps, and regulators. We continued the participation in the technical committees CT82 of EC, CT20/21 of AENOR for preparation of standard.

We have developed the following projects:

- "Analysis of the solar spectrum in Madrid", Autonomous Community of Madrid (CAM). In this project we studied the variations in the spectral distribution under different seasonal and atmospheric conditions and their application to PV systems.
- "Calibration of PV sensors", Concentrator Action, EC, Program JOULE. measurements and comparison and calibration of different sensors of solar radiation for PV use.
- "Project Sahel", the Committee against the desert-ization of the Sahel area (CILSS), DG VIII-EC. Qualification tests for different PV systems will be installed in the Sahel area -- illuminations, chargers and refrigerators.
- "1 MW PV power station" , Frenosa Union. Treatment of the meteorological data of the area, where the plant will be installed. Test and analysis of the modules.
- "Simulation and modeling of PV components" Concentrator Action DGXII-EC. Tests and measurements of the different PV components (modules, inverters, etc.) for obtaining the characteristics and modeling.
- "Measurements of lights for PV use" District of Andalusia. Determination of the functional characteristics and durability of wide spectrum of lights and

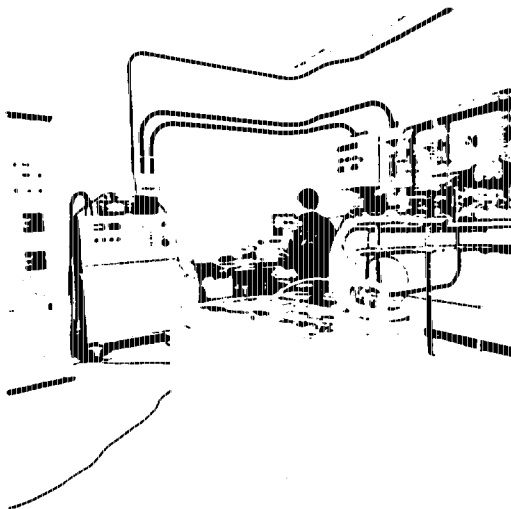


commercial appliances for PV use.

- "Measurements and tests of water pumping systems for agricultural applications via PV energy." District of Andalusia. Start up of a test bank.



Evaluation of PV system for illumination for project Sahel.



Test bank for PV pumping.

- "Tests and measurements of PV systems for air conditioners" DG XII-CE. Qualification of the air conditioning system, powered by PV energy.
- "Project OASIS", DGXIICE. Program JOEL. In this project we performed characterization and degradation of commercial modules of amorphous silicon. The performance characterization of the modules was done by a large area continuous solar simulator, used as a light source.

## Experimental Installations

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This group participates in the management, design, installation and monitoring of the experimental electrification by means of PV solar energy projects in collaboration with EC, DGXII, (Program JOEL), DGXVII (Demonstration project and the program THERMIE), DGVIII and other international organs, CCAA, Universities, Technical Schools and environmental enterprises.

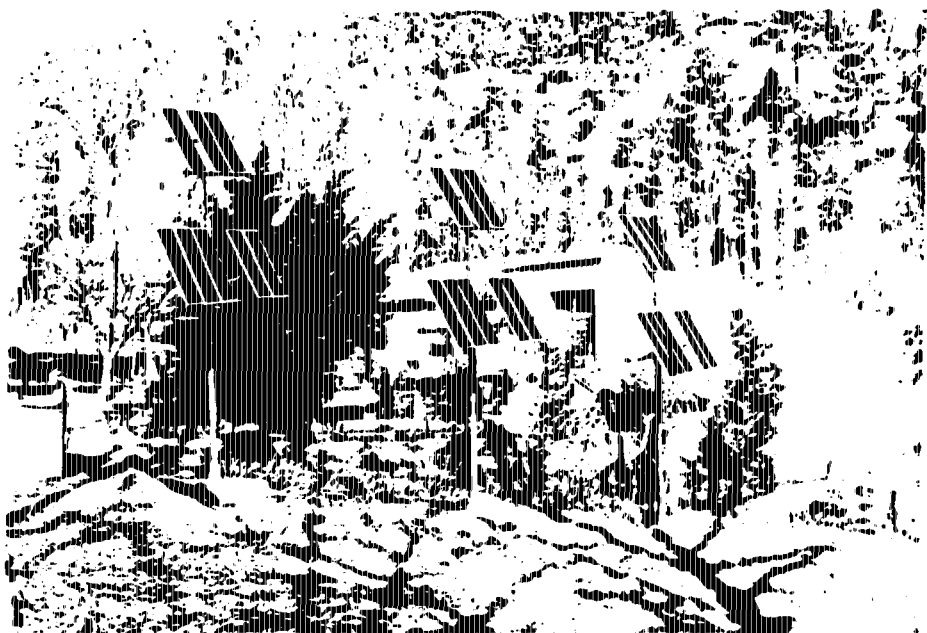
The projects in which we participate are as follows:

- Electrification of a dairy for milk production, using solar energy, in Pozoblanco, Cordoba, in collaboration with "Centre d'Energetique d'Armines" of "L'Ecole des Mines de Paris", within the program JOULE of DGXII of EC. During this year we initiated a second phase, consisting of optimization of a mixed diesel-PV system for the electrification of the above mentioned facility.



PV installation, located in Los Moralejos, S. Segura Jaen.

- Electrification via PV of a water purifier in Camarma de Esteruelas, Madrid in collaboration with BP Solar of Spain, the Community of Madrid and the



A remote PV installation in Prados de la Presa, S. Segura, Jaen.

District of Camarma de Esteruellas, within the program THERMIE of DGXII of EC.

We are also collaborating in task 16, "PV in buildings" of the program "Heating and Cooling" of the International Energy Agency.

#### WIND ENERGY

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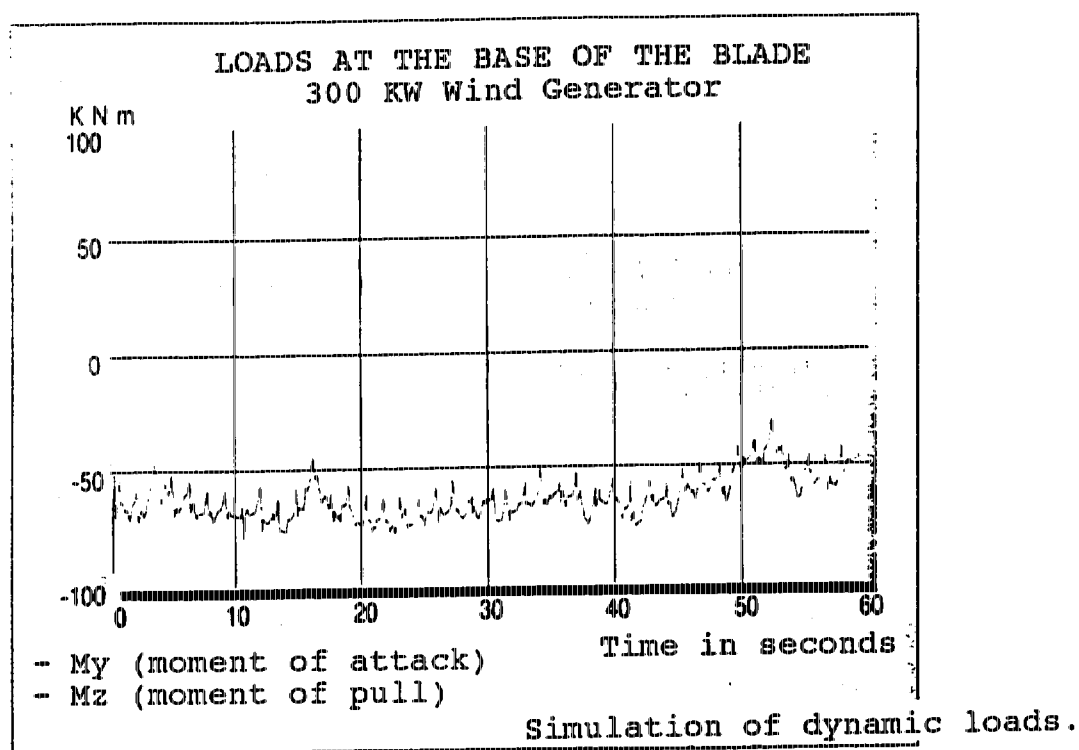
The Wind energy division continued the research activities through different projects in collaboration with the national manufacturers of wind generators, electric companies and other national and international research centers.

#### Technology of Wind Generators of Low and Medium Power

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We continued the development of polyester reinforced fiberglass blades, for wind generators of 20-30 m diameter. We concentrated on the mechanical characteristics and fatigue in the different types of laminates, which are used in the blade fabrication process. In this new process development, all procedures are directed toward lowering the cost and improving the quality control. The blade test processes are geared toward improving the fatigue

factor, present in the structure during its life time of 20-30 years.



In studying the environmental impact of the wind energy fields, we studied the impact of these on the wind energy park in Cabo Villano and Tarifa, covering different aspects of the visual impact, impact on bird life and noise. This was complimented by the opinion study, done by the Human Factors group at the Institute of Nuclear Technology of CIEMAT.

#### Technology for High Power Wind Generators

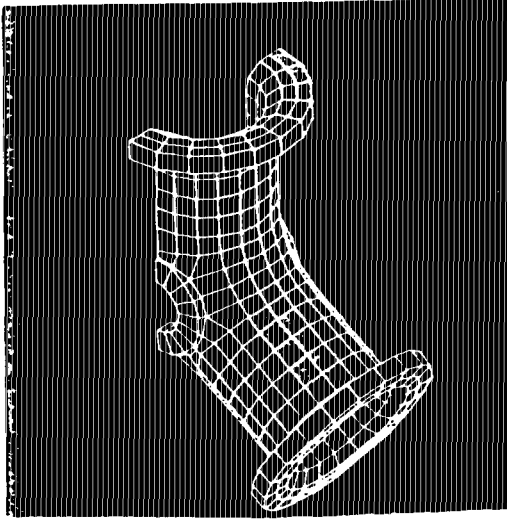
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In collaboration with the Fenosa Union we continued the evaluation of the wind generator AWEC-60, within the JEOL project (DGXII of EC), "Follow up WEGA", together with three other European centers -- Elsam, Denmark, Richborough, UK and Gamma-60, Italy.

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In collaboration with other five European research centers we completed the project JEOL on "Establishing a procedure to determine fatigue in





Model of Buje 300 kW Wind Generator.

wind generators in 1 MW range". This allowed us to improve the computations of the program EOLO, which obtains the aerodynamic loads in different components of the generators. This allowed us to calculate not only the quasi-stationary conditions (old model), but also in the transitory state of change (slow down and speed up), which require more detailed calculations, for determining the optimization of the design of the different components of a wind generator.

We maintained the Spanish presence in different international forums, and especially in the Executive Committee of Wind Energy of the International Energy Agency. We participated in Annex IX "Effects of the interferences of the streams of wind generators" and Annex III, "Cooperation in the development of large wind generators". We also participated in the contractors meetings of the program JOEL in the DGXII in EC in Maastricht, Holland.

#### BIOMASS

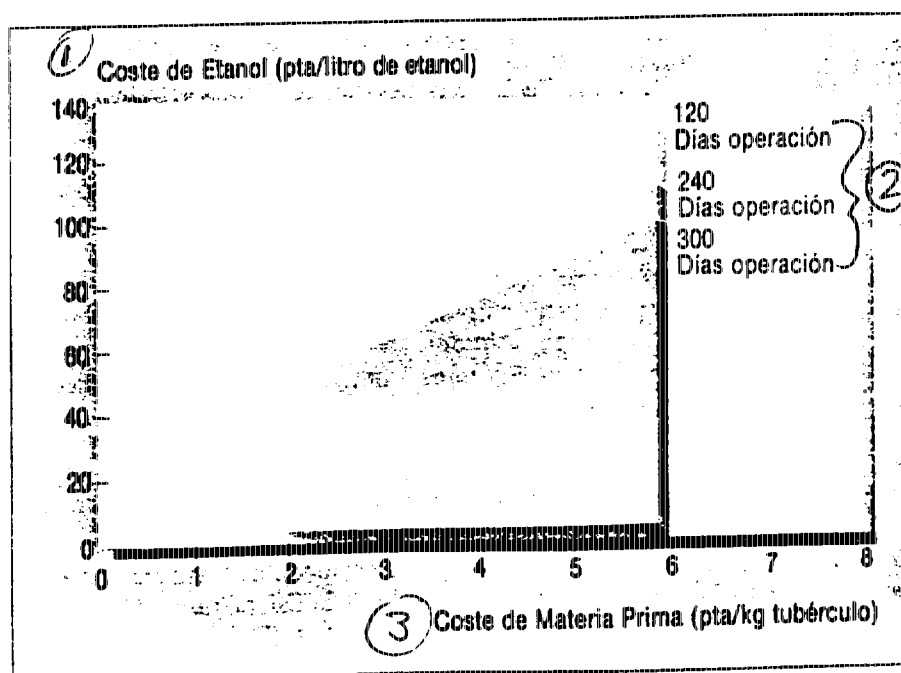
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The activities during this year are a continuation of those, initiated in 1990, within the different National and EC projects.

## Production of Liquid Bio-cumbustibles from Biomass

The project was focused, as in previous years, on obtaining bio-ethanol, after the conclusion of a study for EC on the technical-economic evaluation of the production of ethanol from biomass via acid hydrolysis of the tuber and the following fermentation of hydrides.

Through the pilot tests done at the bio-ethanol plant of the French enterprise ARD, the study achieved satisfactory results from point of view of the technical feasibility of the process, although we still have to study in depth the difficulties, which can be encountered in a large industrial scale fermentation process, because of the high viscosity of the hydrated acids.

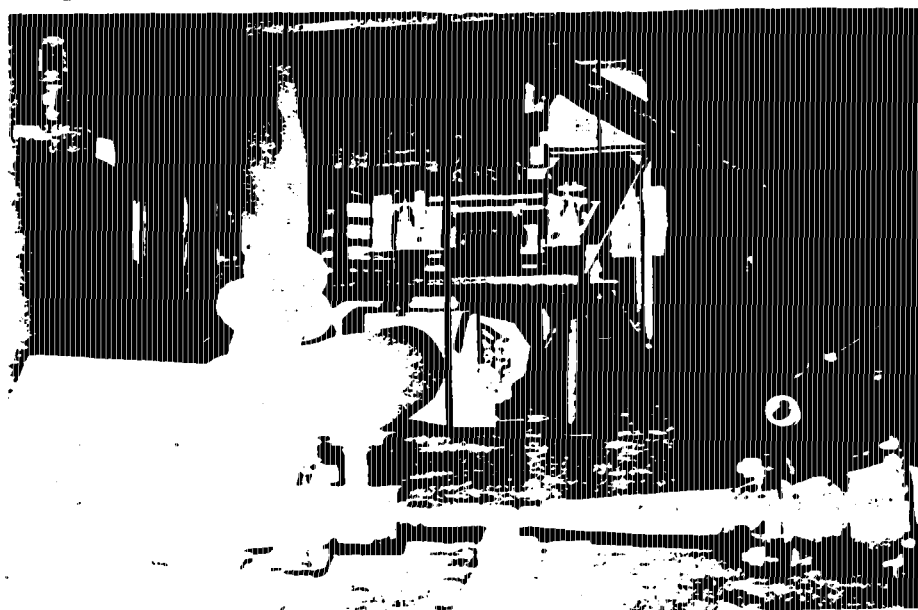


Cost of dehydrated ethanol production from gerusalem artichoke in a 100 Hl/day plant.

Key: (1) Cost of Ethanol (pesos/liter of Ethanol); (2) Days of operation; (3) Cost of raw materials (pesos/kg. tuber).

From an economic point of view, the cost of fabrication, excluding the cost of the initial biomass, was estimated at a cost of 31 pesos/l of dehydrated ethanol, which can be translated into a total cost of production of 94 pesos/l and a raw material cost of of 5 pesos/l of tuber.

In relation to the results on ethanol production, from starchy raw material, the principal activities of the I+D were focused on the transformation of a ligno-cellulose biomass by acid and/or enzyme hydrolysis of the same and fermentation before, or during, the sugar formation. In this sense we included the project of the program JEOL of EC "Development of chemical fractioning of the ligno-cellulose biomass for ethanol production and low cost sugars." CEDER at Lubia is considering a pilot plant for development of a new process, named acid hydrolysis "flash" from lignine-cellulose biomass. During 1991 we concluded the basic engineering and details of the plant, and also the major parts of the equipment for the same.



General view of the biomass acid hydrolysis plant at CEDER.

Within the study of this project we developed different processes for fermentation of hydrolyzed acids of ligno-cellulose, among with we include the simultaneous fermentation of pentose and hexose, present in this medium.

Parallel with this, we continued the study of sugar formation and simultaneous alcoholic fermentation (SSF) of cellulose. We obtained interesting results for isolation and selection of stock from thermal tolerant yeasts, which can

produce better results in the ethanol yield, related to the process of sugar formation and separate fermentation. The best results in this field were obtained with a stable stock from *Kluyveromyces marxianus*, with which we have obtained ethanol yields of 85%, as compared with the theoretical value in three days at a fermentation temperature of 42°C.

#### Energy Application of Waste

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We continued the development of a pilot plant for different processes and technologies for using energy from forest and agricultural

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wastes, whose activities were continued at CEDER as the project "Energy evaluation of biogas, produced in the controlled urban solid waste dump, RSU at Artigas of Bilbao and at Colmenar Viejo in Madrid.

In the first of these waste dumps, we continued the sample taking effort and biogas analysis in six existing holes, with the object of determining its composition: halogenated components, hydrosulphates, which can have a corrosive effect on the processing equipment.

As a result of the study in the waste dump in Colmenar Viejo we concluded that the quantity of the extracted gas from 1988 was approx. 1,000Nm<sup>3</sup>/h, thus the best application for its use is generation of electricity and supply of heat to a near-by facility.

In the energy application of forest and agricultural wastes, we initiated, by an order from the Assembly of Castillo and Leon (Advisory Board of Economy and Housing) and the Hydroelectric plant of Navarra, studies to determine the biomass potential in these regions, and to establish a plan for its utilization. The position of CIEMAT, as a coordinator of the European project LEBEN, was strengthened through the first study, mentioned above.

We concluded work on the production and characterization of briquettes, made out of different types of forestry, agricultural and paper industry waste -- from wood, which was abundant in the region of Castillo and Leon. The results contain information of interest to the industries, offering them cheaper waste additives in their production of briquettes. Together with the mentioned studies, this reinforced the role of CIEMAT as consulting organ and assistant for industry, and Autonomous communities, in the application of biomass waste.

We also finalized the evaluation of the gasification plant of 150 KW, operating at CEDER, determining the optimum conditions of its operation, in order to obtain the maximum energy yield of gas and vegetable coal.

In the plant of fluid bed combustion at CEDER, we designed the modifications of the systems for supplying air and fuel, dissipation and collection of heat and smoke filtration, in order to clean the process. At the same time we increased the capacity of the plant to 1 MW.

During this year we developed a process for the pyrolysis of biomass in Galicia and concluded the monitoring of coal furnaces, using pellets of biomass, in collaboration with the enterprise of Fenosa Union and Castilla-La Mancha Forestry. In the first of these projects, the work done during 1991 consisted in the detailed definition of the methods applied, in order to obtain better results for drying of biomass in Galicia, in accord with the study, which concentrates on obtaining particles no bigger than 2 mm, and maximum humidity of 15%. We also studied the basic design of a potential plant for crushing and natural drying of biomass for the studied process, with a capacity of 2,000 kg/h.

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Another activity at CEDER is the production of biomass from black poplar.

In the fall, we initiated an experimental plant for 3, 4 and 5 years of old black poplar, in order to evaluate the biomass production of 12 different

products and for different ways of cultivation. This experience supports the data of the European black poplar cultivation, existing at the program JOULE of EC.

#### Environmental Biotechnology

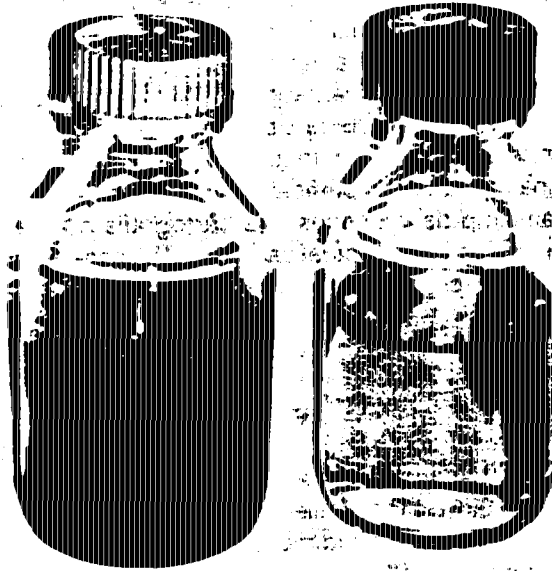
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In this horizontal project, in which the environmental Institute at CIEMAT participates, the Biomass Division developed its activities in three areas:

- Biological purification of industrial waste water
- Production of compost from waste biomass
- Study and minimizing of the contaminant effects, produced by RSU in controlled waste dumps.

In the first of these, we initiated within the program ECLAIR of EC, a study of the de-lignification and discoloration of waste water from paper mills, using ligninolytic micro-organisms. During this year we studied the optimum conditions for cultivating different types of fungus and actinomycetes, which were previously selected for their ligninolytic capacity. In the described tests, the best results were obtained by fungus *Tremetes Versicolor*, which is capable of up to 80% of color from effluents of the paper industry.

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In the area of composts we continued the activities, initiated in 1991, with compost of pulp of sorghum. We studied, in the laboratory, 24 mixtures of pulp from different forest, agricultural, urban and industrial waste, in order to determine the initial physical-chemical characteristics of the raw materials for compost, and also the feasibility of this process on the industrial scale. We also initiated in the last trimester, the first tests on pilot scale in static batteries, with and without air percolation, utilizing as a substrate base the above pulp.



Effluent from the paper industry. Before, left; and after, right biological treatment.

This activity was initiated within the program JEOL of EC "Production of compost from pulp of sweet sorghum".

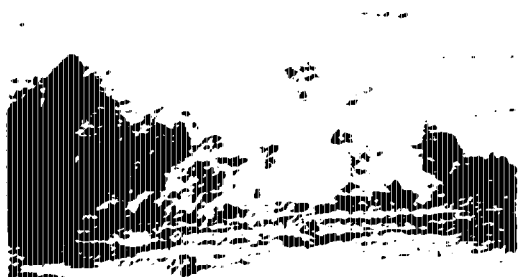
In this area we also consider the work done, within the project partially financed by the County of Madrid, for compost of different wastes, abundant in this area -- mostly straw. During 1991 we studied and correlated the physical-chemical changes and the toxic properties of the products, produced during the compost process of the straw, mixed with different types of forestry, agricultural, cattle and industrial wastes.

Finally, we initiated a project, in collaboration with the Autonomous University of Madrid, and partially financed by the Autonomous Community of Madrid, to study the effects produced by five controlled waste dumps in this region, on the water, soil, vegetation and air in proximity to this installation. The object of this study is to obtain information on the technology and management of the wastes, and to minimize the possible negative environmental impact.

## Resources

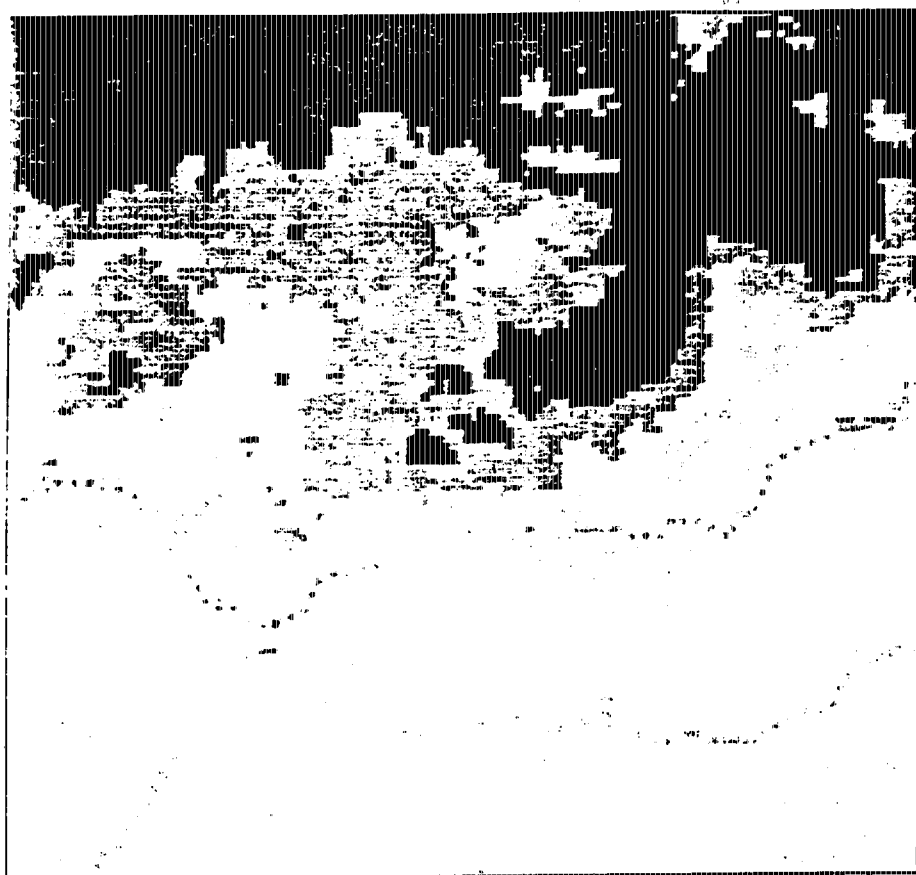
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The activities of the this section can be divided into three areas of priority:

- Evaluation of the solar radiation for applications as an energy resource: here the most important activity is the preparation of high resolution maps, of the solar radiation in Andalusia, starting from "Satellite images". This was done through the specific agreement with the Development Advisory Board of the Assembly of Andalusia. We obtained partial reports, in the form of tables and monthly maps of the global daily radiation, with less than  $20 \times 20 \text{ km}^2$  resolution.
- We continued the data acquisition and treatment of images and the mapping of the results. The management of the data base for solar radiation and the associated climatic parameters.
- Wind resources and the selection of places for wind plant installation, and the development of the project "Measurements and wind models in complex terrain", under the program JEOL of EC and in collaboration with 9 European research centers, were the priorities in this field. We obtained measurements from zones of elevated wind velocity at the peninsula of Iberia (Galicia, Valle de Ebro and South of Portugal) and we are applying tri-dimensional models of wind flow, incorporating topography, thus obtaining images of the wind energy in this zone. We expanded the evaluation and feasibility studies period until September 1993.



Hot compost pile of sugar cane.





3,500 wh/m<sup>2</sup> day

2,500 wh/m<sup>2</sup> day

Map of the average daily solar radiation in November of 1991. Each pixel corresponds to a 7.5x7.5 km. square.

- Economic analysis: the activities here were developed through two specific actions. The first is the advance of the research project on: evaluation of potential market for wind application in Galicia and Valle del Ebro, after characterization of the local energy demand, and after defining the configuration of the corresponding wind systems. Secondly, we initiated the "Technical and economic studies of the PV energy and its most characteristic application", with the objective of evaluating the situation and the market perspectives for PV applications in diverse areas and energy demands.

## Support Unit

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The support unit provides support services to the Directorate of the Institute of Renewable Energy (IER) in internal management and accomplishing these internal activities, which are required by the other operating units.

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Presently the responsibilities are in the following areas:

- Information and electronics
- Support group
- Library and documentation
- Technical office: outline and project prototypes
- Maintenance and operation of installations

With all these activities we also provide liaison among all CIEMAT departments, in order to optimize the available resources.

The support group coordinates the administrative and management aspects, related to budget investments and expenses, inventory, material and personnel acquisition, etc., in collaboration with the other CIEMAT Directorates, and also with the General Technical Secretary and Control of Operations.

The most important role of the support unit, as regards to the technical aspect of their work, is not only maintenance of equipment and installations, but also the design and start up of systems and application of programs, optimizing information and electronic resources, available to IER. In this sense the support works and assistance, undertaken at IER, represent the most labor intensive activities.

The support unit also has its own projects, such as: "Simulation of renewable energy systems" and "Normalization of the data acquisition systems", in collaboration with the other IER projects, in order to provide an unique solution to the different renewable energies.

The support activities and assistance include the necessary work for the functioning of the IER activities and the specific project developments, such as:

- Experimental installations.
  - Passive: Aguilar de Campoo, Guillena, Module tests.
  - Pozoblanco PV
  - Wind energy: AWEC-60
- Treatment of experimental data
  - Biomass: Black Poplar plant at CEDER
- Development of information applications.
  - Following of economic data. Analysis of forecasts and actual expenses
- Information support
  - Passive: work station SUN, integration of the management network etc.
- Pilot plant and tests
  - Wind energy: behavior of blades. Test of materials

## PUBLICATIONS

	SOLAR	WIND	BIOMASS	RESOURCES	TOTAL
Articles in Magazines					
National	9	—	—	—	9
International	16	2	1	—	19
Books	4	1	1	1	7
Thesis	1	—	—	—	1
Dissertations	4	—	—	—	4
Presentations					
National	4	—	1	—	5
International	42	—	9	1	52
CIEMAT reports	—	4	1	6	11
Internal reports	35	—	—	—	35
Area reports	62	—	12	—	74
EC reports	47	7	8	1	63
Reports to enterprises	3	6	8	3	20
Procedures	10	2	—	—	12

## SIGNED AGREEMENTS IN 1991

ORGAN OR  
ENTERPRISE

## GENERAL AGREEMENTS

- Agreement between Higher School of Mines, France and CIEMAT

EMP

- Creation of European agency of renewable centers

EEIG

## SPECIFIC AGREEMENTS

### SOLAR

#### PASSIVE SOLAR ENERGY

- Development of simulation methods and energy analysis of passive solar buildings EMP
- Innovative projects in promotional public housing with passive solar systems in Mendilori, (Pamplona). Phase I CEE
- Energy analysis and evaluation of buildings in bio-climatic projects. FGUPM
- Simplified design methods and evaluation models for determination of energy behavior of buildings. AICIA
- Evaluation and measurements of the behavior of the techniques for conditioning of the outdoors for EXPO '92 AICIA
- Evaluation and measurements of the behavior of the techniques for conditioning of the outdoors for EXPO '92 JA
- Passive and active solar design, based on the ventilated attic concept for three blocks of public housing projects. CEE

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### High Temperature

- Intensification and new developments in industrial processes through solar radiation. ISFH
- 6th International conference on thermal solar concentration in Mojacar, Almeria from September 28 thru December 2, 1992 CEE
- Design, construction and tests of a 2.5 MW volumetric air receiver. FDE

### Environmental Technology. Solar Detoxification

- Solar energy effect for organic solvent degradation. Development of its application for treatment of wastes. CAM
- Destruction of toxic and dangerous waste with high temperature, concentrated, solar energy. CAM
- Solar concentrators, developed through holographic techniques. 3rd phase. UA

### Laboratory of Photovoltaic Modules and Components

- Agreement for collaboration on the optimization of amorphous silicon solar models. Derived from contract CE-JOUR-0007-C.  
DELFT  
CHRONAR  
U.EINDOVEN  
UNINOVA  
U.UTRECH  
U.STITGART  
IMEC  
CIEMAT

- Calibration of solar sensors CONPHOEBUS
- Energy resources for solar radiation CAM  
in the Community of Madrid; measurements and  
spectroanalysis. Application of PV systems.
- Central 1MW PV electric generating station UEF  
for Spain. Project in progress.
- Evaluation of pumping equipment for agri- JA  
cultural PV applications.

#### Experimental Installations.

- PV exploitation of the cow farm in CEE  
Pozoblanco, Cordova. 2nd phase.

#### Wind energy.

- Procedure for establishing the fatigue ECN  
factor in large wind generators.
- Static resistance and fatigue test in ETSAIG  
materials made out of glass, fiber, resin,  
polyester, with specific lamination.

#### Biomass

- Collaboration in the field of biological SAICA  
processes of discoloration of effluents  
of the paper industry, within the contract  
AGRE-CT90-0044, SMA.

- Collaboration in the field for utilization of sweet sorghum in the contract n JOUB-0036-C of EC. UPM
- Agreement of cooperation, related to contract JOUB-CT-0065 of EC. BERTIN
- Fabrication of high quality briquettes, from waste biomass for energy applications. CAM
- Agreement of cooperation, related to contract AGRE-CT90-004, SMA REGIS
- Study of environmental degradation, due to solid waste dumps in 5 locations of the Community of Madrid. UAM
- Compost of sweet sorghum. Derived from contract CE-JOUB-0036-C. CEBAS (CESIC)
- Design of process for bio-discoloration of effluent from the paper industry (ECLAIR-AGRE-CT90-0044.) CICYT
- Study of the energy potential of the controlled waste dump at Colmenar Viejo. SERMASA
- Study of the gases, generated in the urban solid waste dumps: atmospheric contamination and environmental degradation, produced by these. CAM
- Evaluation of the potential and development of biomass methods and applications in Castilla and Leon. JCYL  
UVA

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- Evaluation of the biomass potential and the possibility for its application in Navarra. AIN

#### Resources.

- Evaluation of the market potential of applications of wind systems in Galicia and Valle del Ebro
  - AE-DGA
  - GESTENGA
  - SINAE
  - LNTI
- Measurements and wind modeling in complex terrain. Application to zones of elevated wind activities in the Iberic peninsula: Galicia Valle del Ebro and South of Portugal
  - AE-DGA
  - GESTENGA
  - SINAE
  - LNTI
- Preparation of high resolution solar radiation maps from satellites images (Meteosat), for Andalusia. SYPER
- Preparation of high resolution solar radiation maps from satellite images (Meteosat), for Andalusia. CFTJA
- Start up and analysis of the functioning of a fuel plant for phosphoric acid. ENAGAS

ENVIRONMENTAL  
INSTITUTE

TECHNICAL  
SUPPORT

INTERNAL  
RADIOLOGY  
SAFETY

OUTSIDE  
RADIOLOGY  
SAFETY

GEO-CHEMISTRY  
AND  
ENVIRONMENTAL  
IMPACT

CONVENTIONAL  
ENVIRONMENTAL  
SCIENCE

MOLECULAR  
AND CELL  
BIOLOGY

## ENVIRONMENTAL INSTITUTE

The Environmental Institute (IMA) of CIEMAT has as an objective the research studies, technical support and service related to control, destiny and effects of contaminants from energy production. The same objective, although focused on control, corresponds also to the environmental Technology programs of CIEMAT, in which four Institutes participate and which is coordinated by the Directorate of IMA.

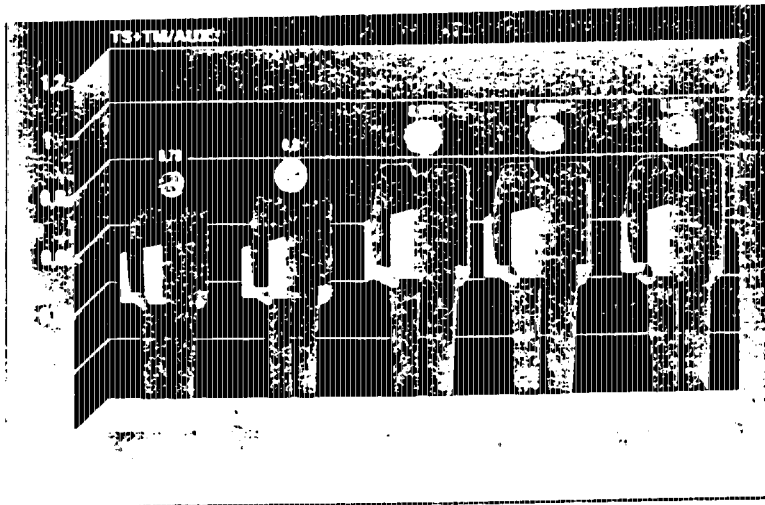
With the advances and achievement in our objectives, we favor the compatibility between the industrial sector (energy in particular) and environmental quality. In the development of these activities we encounter the interaction industry-environment, and arrive at areas, which involve an increase or decrease of the industrial impact, or which propose correction of the industrial activities. From this point of view we evaluate the conventional and radiology contaminants: those which only have a potential for such, and those which are present in normal or emergency situations, or due to bad practices.

PERSONNEL DISTRIBUTION				
UNITS	TS	TM	AUX.	TOTAL
Directorate	1	—	1	2
Technical Support	10	3	7	20
Internal Radiology Safety	11	1	34	46
External Radiology Control	16	1	18	35
Outside Radiology Safety Geo-chemistry and Environmental Impact	11	—	9	20
Conventional Environmental Control	16	—	11	27
Molecular and Cell Biology	18	1	14	33
<b>TOTAL</b>	<b>83</b>	<b>6</b>	<b>94</b>	<b>183</b>

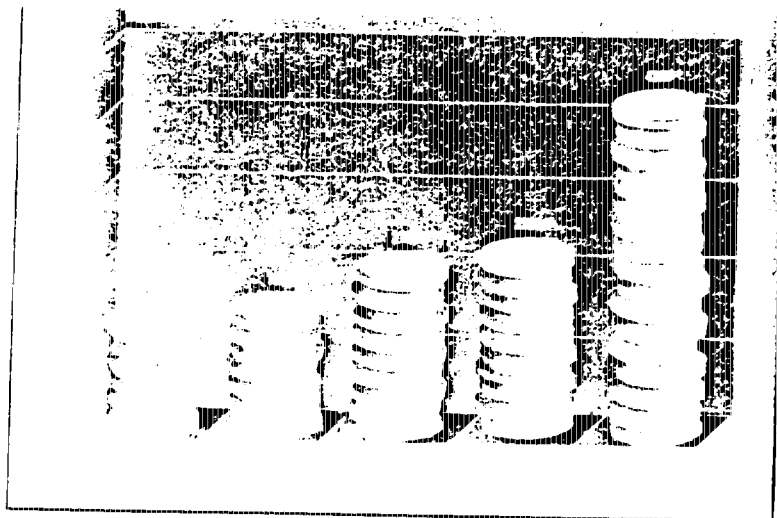
INVESTMENT AND INCOME DURING 1991 (MPTA)

UNITS	INVESTMENT	INCOME
Technical Support	21,6	—
Internal Radiology Safety	71,2	82,4
Outside Radiology Safety	52,6	192,3
Geo-chemistry and Environmental Impact	19,6	76,4
Conventional Environmental Control	51,4	51,0
Molecular and Cell Biology	35,6	35,5
<b>TOTAL</b>	<b>252,0</b>	<b>437,6</b>

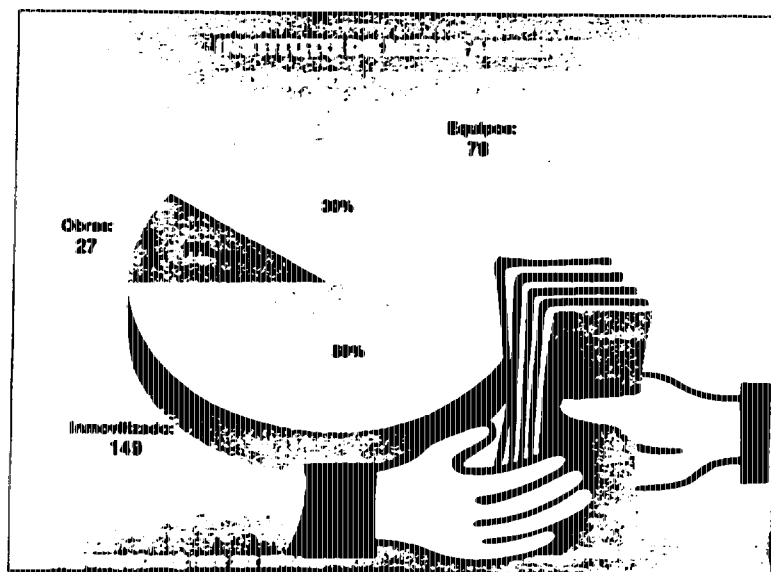
ENVIRONMENTAL INSTITUTE  
PERSONNEL EVOLUTION



# ENVIRONMENTAL INSTITUTE INCOME EVOLUTION



## ENVIRONMENTAL INSTITUTE (ILLEGIBLE)



The achievements, technically speaking can be classified as environmentally focused, derived from placing substances and energy in the environment. With the action on the control level, and on the study of the destiny of the contaminants, we are capable of measuring and evaluating technologies and methods, useful for enterprises. With the study of the destiny and the effects, we try to optimize and stabilize the environmental standards, clarifying the direction of industrial activities.

The research of IMA can be qualified as applied to technologies. with attention to the basic phenomena and for assuring the implementation and renovation of the capacities and the proposals. Starting with the planning it is necessary to ensure the interest of the potential users of the IMA activities, which requires orientation and planning, to fit the demand of these users. The activities are oriented and implemented in three basic areas: enterprises, administrations and research programs. The European scientific and technical programs constitute the latter programs.

In the world of enterprises, the orientation is prioritized in the area of energy, with a main customer ENRESA. The relations with other energy enterprises are to be developed within the plan of energy research.

We interact with other administrations, competent in energy and environment, through the priority relation with the Secretary General of Energy and Mineral Resources (SGERM), with the Counsel of Nuclear Security, CSN.

We participate in research programs of EC in the National plan and the plan of the Autonomous Communities. We have to emphasize the participation in programs of competitive nature (if not basic) in the context of the main plan. With this we assure a product of social and economic interest to the enterprises and administrations, with quality guarantee. This provides International cooperation in the area of the European programs.

To satisfy the demand of the three generic users, we collaborate with 40 foreign institutions, mostly European, and 20 Spanish, establishing an opportunity for formal relations.



The involvement of other Spanish centers and Universities in the environmental and engineering fields is evident. We keep in mind the competition, through the application of two basic principles: we tackle basically problems and not disciplines (which is different from the direction of the universities and some research organizations). We also do not interfere with the established industrial operations, except for providing technical support and services. These in many occasions are accomplished with the help of engineering.

The relation of the projects to IMA's activities is demonstrated as follows:

- We concentrate on control and avoidance of emissions and waste in the plants, by implementation of clean control technologies and for the optimum environmental results.
- We understand, by studies of the destiny of the contaminants, the phenomena of transport, diffusion, transformation etc. of the contaminants in the physical media and its interfaces, as well as in the chain of its evolution until they reach a collector or storage.
- The studies consider the action taking place in the receivers of the contaminants, and evaluates the damage data, as well as the interaction mechanisms.

## RESEARCH ACTIVITIES OF IMA

	RADIOLOGY	CONVENTIONAL
CONTAMINANT CONTROL	• Occupational Radiology Safety	• Environmental instrumentation. Optimization of the environmental adaptation in industry (1)
DESTINY OF THE CONTAMINANTS	ENVIRONMENTAL RADIOLOGY SAFETY • Environmental impact of Nuclear Technology • Radiological impact of radionuclides	ATMOSPHERIC CONTAMINATION • Physical Chemistry of the atmospheric contamination • Industrial Risk: Dispersion in the atmosphere (2)
EFFECTS OF THE CONTAMINANTS	EFFECTS OF THE ENVIRONMENTAL AGGRESSORS	
	• Biological effects of the environmental aggressors	• Industrial risk: effects on health (2) • Effects of atmospheric contaminants on vegetation.

- (1) Included in the environmental technology program of CIEMAT  
 (2) Included in the industrial risk program of CIEMAT

## ACHIEVEMENTS DURING 1991

### RADIOLOGY SAFETY

#### Environmental Radiology Safety

The direction of research during 1991 by CIEMAT's projects includes:

- Environmental impact of nuclear technology
- Radiology impact and behavior of the radionuclides of long life.

This activity in its entirety produced in 1991 65 documents, 27 of these were published, to which we have to add 50 reports to customers on the results of the radioanalytical activities.

The generated confidence in the nuclear electric industry is based not only on the development of interest in safety, but also on the demonstrated ability in waste management and the ability to confront accidents, but also in maintenance of normal control of operations.

As far as radioactive waste is concerned, the principal objective is to make the methods for radiology analysis available for Spanish users. This is indispensable for the licensing of storage facilities, or for any other aspect of management.

After an accident has occurred, the object is to find, evaluate and permit the selection of optimum remedy action, which will allow the return of social and economic normality in the region.

Through studies and development of quality control programs, we provide support to the operation of nuclear stations and related installations in the cycle of fuels in Spain, as well as in the vigilance and decision making on the part of the competent authorities.

In this context the research of IMA in environmental radiology safety tackles the open subject of the state of nuclear energy in Spain and in the world.

#### a) Progress in the development of evaluation capacity

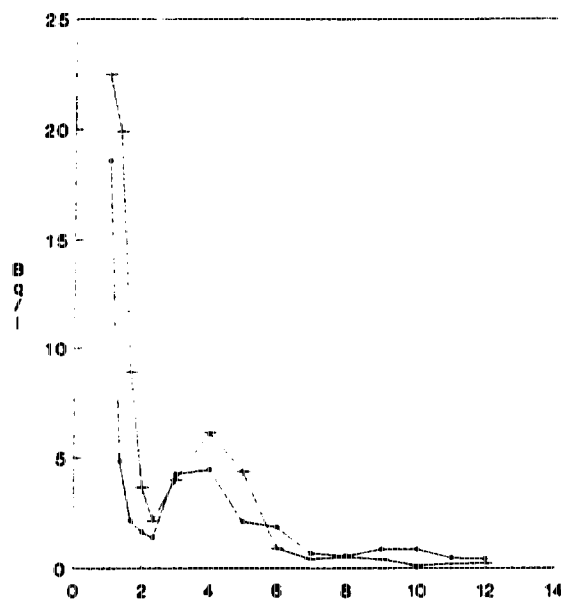
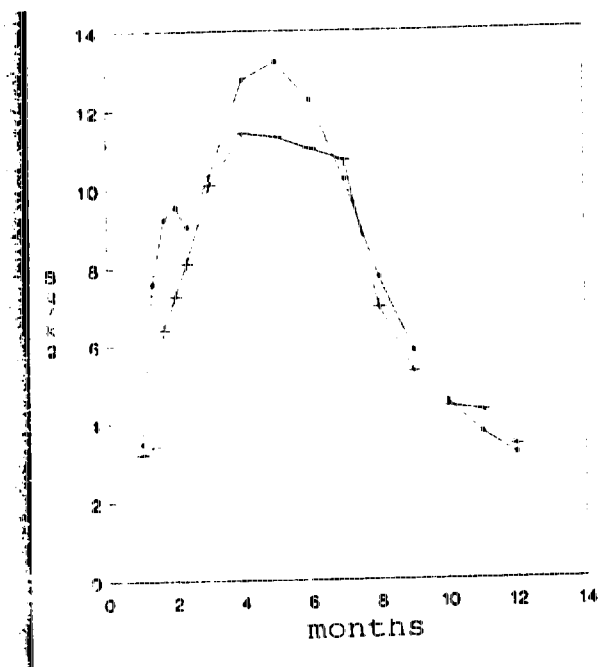
##### Validation of models for prediction of radiology impact

We studied phase II of the International project BIOMOVs (Validation Study of Biospheric Model), where CIEMAT and ENRESA act as promoters and organizers, together with SSI of Switzerland, and AECL/AECB of Canada. We expect the participation of 18 countries. The technical activities of CIEMAT are focused on the validation of uncertainties, long term characterization of the biosphere and the problems of sterile uranium.

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Concentration of Cs-137  
in the Human Body

Concentration of Cs-137  
in Cow Milk



— Predictions of the model PRYMA

+ Actual measurements

Comparison of predictions of the model with real data in an European region, contaminated by the Chernobyl accident (Program VAMP)

We assisted the incorporation of the VAMP activities (Validation of the model for prediction) OIEA-CE. During 1991 we finalized the corresponding exercise, in the water table. We obtained the first results, related to the real post-Chernobyl scenario.

### Specific Applications

The evaluation capacity, which is being developed from year to year is being demanded for specific applications.

The achievements in 1991 in this area were:

- Evaluation of radiology impact for the disposal of debris from dismantling operations by CIEMAT.
- Analysis of the different characteristics of diet and Mediterranean agricultural practices.
- Revision of the EC method of evaluation of drainage from nuclear stations, in collaboration with NRPB (RU), with the help of EC.

### Activities in Committees and Work Groups

- We participate as National experts in forums of EC (EUROATOM, art. 31, art. 37; groups at hoc, OCDE (CRPPH) and OIEA. We have to emphasize the relations with the Spanish installations QUERCUS and El Cabril for article 37 and the work of the Experts Group of article 31 on the standards of nuclear safety.

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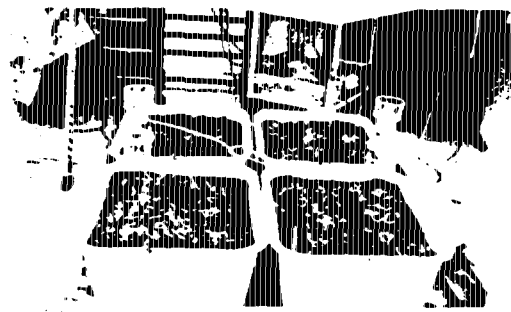
- We are active in the National committees of coordination for the construction of El Cabril (ENRESA) and QUERCUS (ENUSA.)

### b.) Experimental Development in Radio-environmental Studies

We continued the studies and work on inhalation as a contribution to the dose. In these activities we characterized physical, chemical and

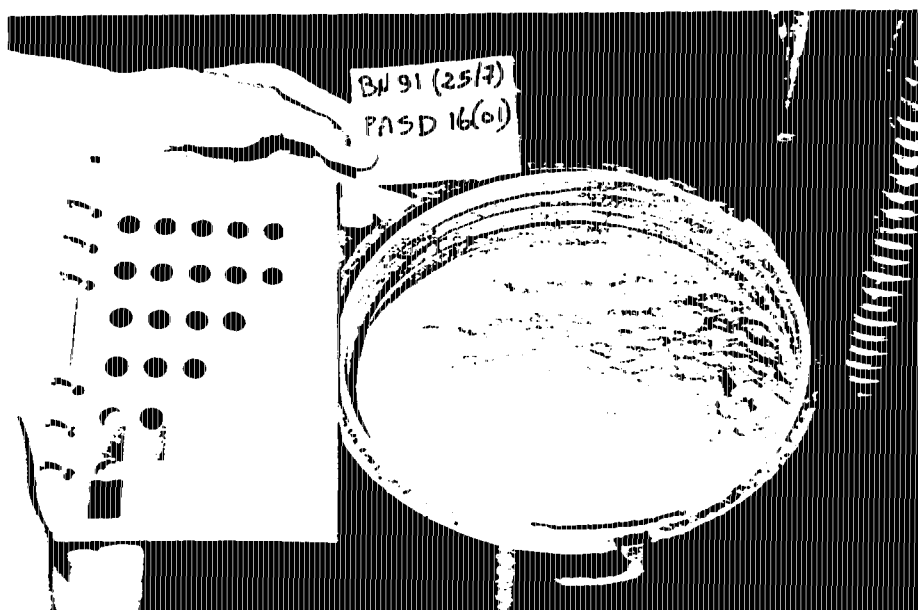
mineralogical properties of inhaled agricultural dust, which was contaminated with Pu and Am for consumption by animals in an experimental project of inhalation in collaboration with NRPB. We achieved an integration with a project, coordinated by OIEA in the area of dosages for inhalation. We also participate in the project EC-Chernobyl Center on the suspension of contaminated soils, with the help of EC, ENRESA.

In this period we finalized the contamination experiments of produce, treated with aerosols, as a part of the project TARRAS, which studies the transfer of accidentally released radionuclides in serious accidents, in collaboration with the University of Barcelona, the University of Reading, CEA-IPSN and Harwel, with the help of EC, ENRESA, CSN.



Contamination of produce with radioactive aerosols, in different state of growth. Experiment developed in Cadarache, France within the project TARRAS.

We initiated an International campaign in the Mediterranean, within the project for behavior of radionuclides in marine life, in collaboration with ENEA, Italy, with the support of EC, CICYT, ENRESA.



Marine sediment. International campaign 1991.

We continued the participation in exercises for analytical comparison and measurements on International level, with the object to guarantee the quality and confidence in the results of the experimental projects.

c.) Studies on the environmental impact of waste management

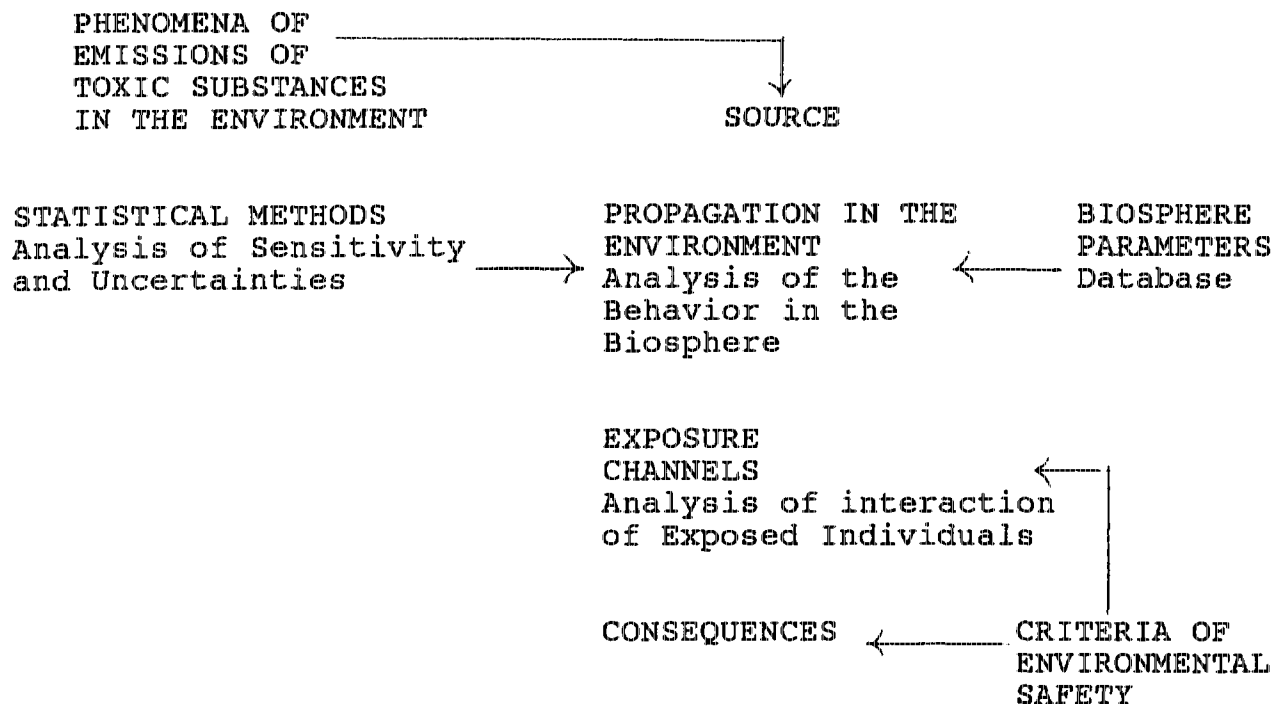
This activity is developed in cooperation with ENRESA, for the modeling of the biospherical parameters and radiology safety criteria. The emphasis is on:

- Study and modeling of potential radiology impact on the ecosystem of El Cabril (point 2.5 of the Declaration of environmental impact.)

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- Completion of the study on the collaboration of the meteorological situations and wind field at the storage site of El Cabril (part B8.1 of the conditions for authorization for construction.)

- Conclusion of the first phase of the analysis for the methodology of evaluation of impact of toxic and radioactive waste in collaboration with Science Intera, RU (with the help of CCE.



Aspects, which are considered for the comparative analysis of the methodology of evaluation of the final disposal of radioactive and toxic waste.

- Completion of the exercises of the biospheric modeling and final disposal. PSAC-1B in the AEN-OCDE.

- Other technical support in ENRESA for contracts with Universities and revision of International documents (OIEA, CE, OCED) etc.

d.) Study of intervention in the last phase of a radiology emergency.

We completed the work of vigilance and evaluation of the radiology impact on the environment and the people in the zone of Palomares. We published the corresponding reports for CSM, as a consequence of this activity.



We completed the characterization of a Mediterranean agricultural soil (red earth) for the project EUROSIL-RESSAC in collaboration with the University of Barcelona, with the help of CCE, ENRESA. This concluded the first phase.

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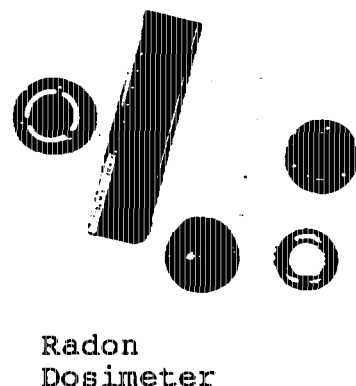
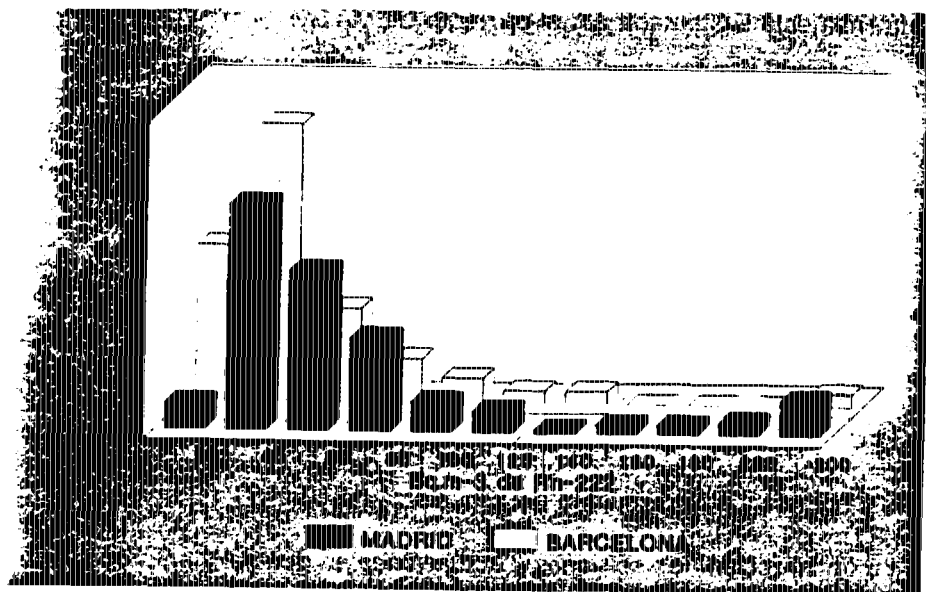
We advanced in the analysis of the countermeasures, through the participation in the International project CE-Center Chernobyl on the evaluation of the contamination strategy and the development of the agreement IPSN-ENRESA on biological contamination of soil and the interception of radioactive deposits by vegetables.

We initiated the development of methodology for establishing levels derived by intervention in collaboration with NRPB.

#### e.) Study of natural radioactivity

We finalized the campaign on vigilance for Radon in housing areas of Madrid and Barcelona, in collaboration with UAB (with the help of CSN, ENRESA) and initiated a new campaign on a bigger scale.

CONCENTRATION OF RADON IN HOUSES  
IN MADRID AND BARCELONA  
Measurements campaign 89-90



We collaborated with the University of Sevilla in studies done by CE on the radiology impact to the forestry industry.

f.) Environmental radioactivity

The important activities of the environmental radioactivity laboratories can be summed up as follows:

- Quality control of the vigilance program PVRAS: "Execution of analysis in samples of PVRAS in 7 nuclear stations (1300 analysis), of samples from ENUSA installation 2000 analysis, and samples from ENRESA installations (1000) analysis.

- Completion of vigilance programs: Execution of PVRAS of CIEMAT (1400 analysis), completion of PVRA of Villa de Madrid, in agreement with the Districts (400 analysis) in addition to the in situ measurements and independent samples of CSN (280 analysis.)

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- Radioanalytical comparison: Organization and completion of comparison of national laboratories (with the support of CNS), in agreement with CSN for the preparation of an exchange between the participant in the REVIRA method and the participation in the international exchange OMS.

- Other radioanalytical determinations: Exact attention to the demands of diverse origin for analysis of water, food and etc., including certificate for radioactive content.

g.) Program I+D in Radionuclear Safety of the EC.

As a consequence of the representation in the Coordination Committee, we completed analysis of results of the program, and the evaluation of the proposals of the 1982-1984 period. The program covers the environmental and occupational aspects.

## Occupational Radiology Safety

This area is supported by the project CIEMAT.

## Interior Radiology Protection

These activities in its entirety produced 44 documents, 6 of which are communications, and a number of reports for dosimetric control to clients.

The activities of occupational radiology protection correspond to the actual control requirements of the origin of the environmental radiology impact and protection of the exposed professionals. These requirements are:

- Control of the normal operation, which although referred to mostly experimental installations, is under the influence of the variations of the techniques and standards in following the control procedures.
- The optimization of decisions and actions in general, and in particular declassification (where the criteria of radiology safety is a necessity).

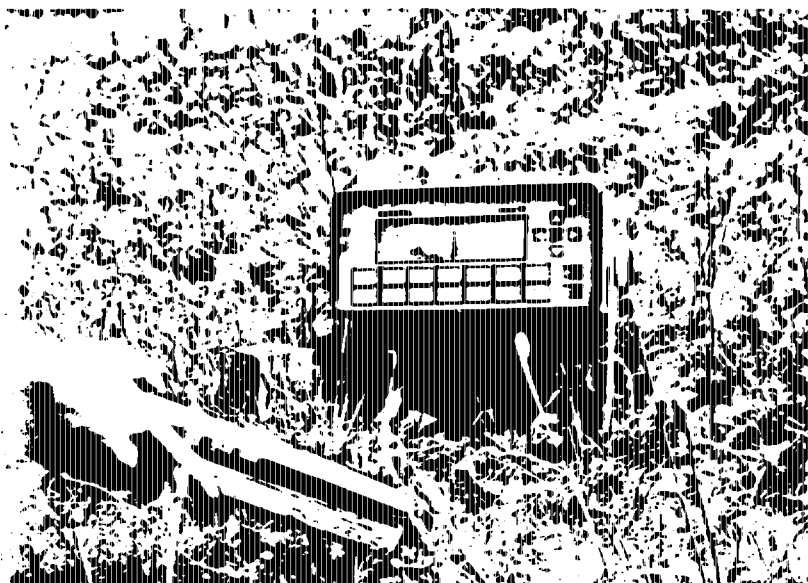
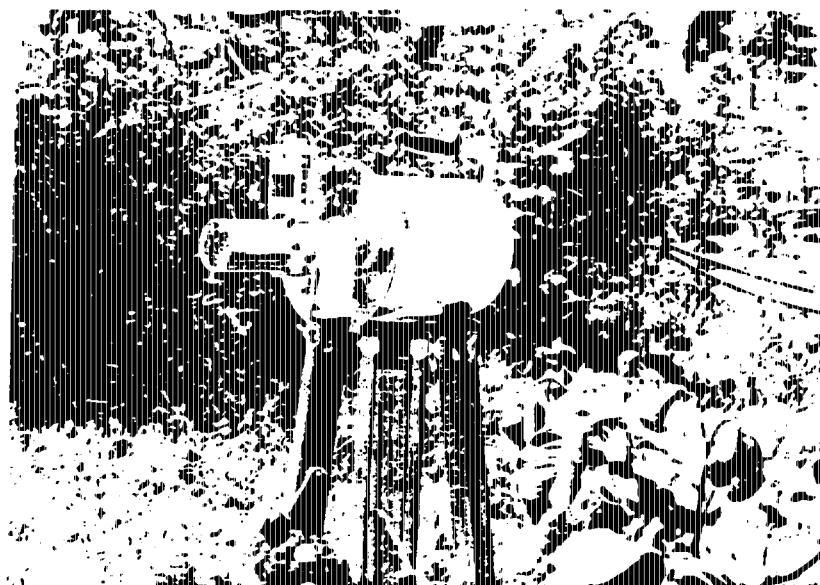
These same requirements are present in CIEMAT, which permits this project to disseminate knowledge project the know how, which is acquired by working on the outside and on the other hand offers the CIEMAT's capacities for radiology safety service when it is required in participation in projects, or in providing technical support and services to the outside as a function of the obtained experience in this type of service.

a.) Meeting the objectives of radiology safety services.

The tendency to decrease the occupational radiology impact at CIEMAT continues. The average annual corporal dosage in 1991 was .02 mSv - 50% less than in 1990. 91% of the professional exposed population, did not register a value above the standard during 1991. The environmental impact of the activities of the center, estimated according to the vigilance plan, were again undetectable in 1991.

The completion of the Occupational radiology safety program, applied at the work place and in the operations allowed: on one hand, the elaboration of periodic reports on the regimental activities of radiology vigilance in the installations, corresponding to the assigned competency of the radiology safety services, and on the other; to formalize the documentation which reflect the operating methods and techniques of the diverse programs, designed for the accomplishment of these tasks.

We collaborated with, and sent, to the Nuclear Security Counsel, documentation, related to the functioning of the radiology safety service and initiated revision #4 of the radiology safety manual of CIEMAT (General Procedure #30). We also prepared 7 specific procedures of the radiology safety service, and revised another one. We completed the radiology control of two areas of the Center.



Environmental Spectrometry analysis. Detectors of Ge(1) and INA(Tl). Detail of the instrument

b.) Coverage and technical capacity for personal and environmental dosimetry.

We analyzed the low base conditions (Mine of Asse, Germany) and the threshold of the dosimetric TL in collaboration with the IB-CIEMAT and RISO and PTB, with the support of CCE.

We started the operation of the automatic system for reading dosimetric thermal-luminescence and information applications for dosimetric management. We solicited an authorization from CSN for change in the dosimetry technique from film to thermal luminescence.

In respect to the internal dosimetry, we finalized the modeling of the body radioactivity counter, and implemented the measurements system. We are now preparing the documentation authorization of the internal dosimetry services. We are also working on the calibration procedure for measurements of actinides in lungs.

The notable activities in this area can be summarized as:

- Completion of the outside personal dosimetry services to 120 enterprises, 44,000 measurements in 1991.
- Completion of 250 internal contamination controls by Uranium.
- Quality control of environmental dosimetry for CCNN, 600 readings.

c.) Radiology safety in decontamination and decommissioning.

At the end of the year we initiated the corresponding activities, according to the new General Plan of Decommissioning of CIEMAT's installations. The activities focus on the reglamentary aspect of information criteria development and methods of PR for shut down.

We continued work on the CE project "Decommissioning of the JEN-1 Experimental Reactor" in the aspect of radiology impact on shut down, decontamination and melt-down of contamination, with the support of CCE.

d.) Technical support activities.

- Collaboration with CSN in diverse vigilance operations.
- Collaboration with ENRESA/INITEC on the decommissioning (FUA)
- Assistance and services, according to the demand and presence at technical forums, as national experts (EURADOS, CE-DGXI.)
- Collaboration with CSN and MCT in the retiring of radioactive sources.
- Completion of radiology tests for the homologization of radioactive apparatus.
- Campaign of mobile units for radiology control per agreement with the District of Madrid.

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#### ATMOSPHERIC ENVIRONMENT

This line of activities supported by three CIEMAT projects. The second one is partially in the area of biological effects of the environmental aggressors. The third part is a part of the Industrial Risk program. The projects are:

- Physical and chemical behavior of atmospheric contaminants.
- Effects of the atmospheric contaminants on cultivation and vegetation
- Industrial risk. Atmospheric dispersion.

During 1991 these activities produced 44 documents, 12 of which are publications and communications.

The technical orientation of the research activities is a consequence of the work done in Spain on the occurrences of atmospheric phenomena and changes in the air circulation and chemistry, which are not well understood, due to the Mediterranean characteristics and the complexity of our land.

Under these conditions the indiscriminate application of methods and approaches allows errors in the evaluation of the impact and the design. Thus, it is necessary to have better characterization and more adequate methods, which allow the improvement of the atmospheric behavior of the contaminants, related to the production and consumption of energy, which can be extrapolated to the rest of the industrialized world.

This extrapolation has an added value on the undertaken effort, and has forced us to integrate the atmospheric behavior (undoubtedly the most relevant) with the consideration of the consequences of industrial accidents, in such a way, that a facet of this activity is now a part of the program of Industrial Risk at CIEMAT.

With exception to the above mentioned atmospheric contamination zones, the battle of atmospheric contamination of Europe is centered in an area of values of concentration of contaminants in the air (inmission) lower than the admitted limits. There are no adverse health effects in this area, but the vegetation is affected.

The important global reduction of Sulphur oxide and Nitrogen emissions (Guidelines on the Great Combustion Centers) is oriented toward the protection of vegetation and not of health.

The call to our attention of these effects, and their causes (generally speaking of acid rain) started in some countries of North Europe and the Canadian-USA border. The circumstances call for consideration of these phenomena on our territory, where clear differences exist on the type of vegetation, contaminant mixtures and their chemical evolution.



a.) Detection, description and interpretation of the Spanish meso-meteorological regulations.

We are close to finalizing the projects "Meso-meteorological cycles on the Iberic Peninsula" and "Regional cycles of contamination of the Mediterranean area". We approved the continuation of the project of "South-european cycles of contamination", with the help of CCE, ENRESA and CICYUT.

We finalized the work for the description of formation and transport of ozone in the stratosphere by the daily coastal breeze at 0-700m elevation.

We witnessed the return of masses of rich in secondary contaminants of the air, to higher stratosphere layers of the coastal zones. We obtained a confirmation of the association between meteorological cycles and the contamination of the surface and elevation, in the summer season.

b.) Evaluation, typification and description of dispersion situations in Spanish storage sites. With the support of CCE, ENRESA, CICYT and CAM.

- Description of the behavior of the locality of Lada and Soto of Ribera, under different dispersion conditions, beginning with following of the moves. With the support of OCIDE.

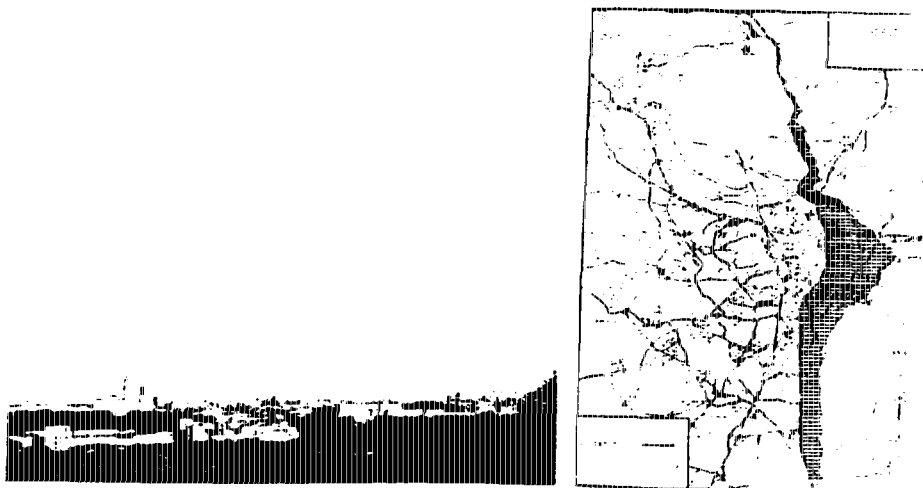
- Completion of summer campaign in the valley of Mijares and its zone of influence Teruel-Castillon.

- Characterization of daily cycle of the acid species of the gas phase  $\text{HNO}_2$ - $\text{HNO}_3$  in the region of Madrid and Castellon.

- Development and demonstration and vertical measurements of the industrial area, by utilization of two remote sensors, COSPEC, in  $\text{SO}_2$  mode and angular configuration.

- Characterization of the dynamic evolution of the Madrid area under episodic conditions, using COSPEC in NO2 mode.

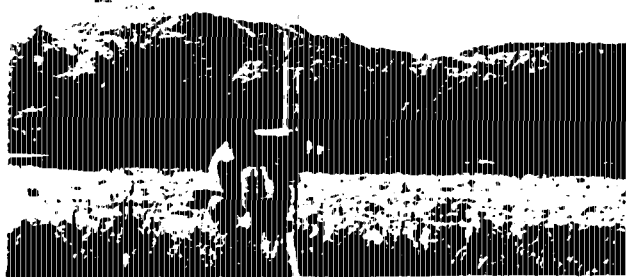
- Selection and implementation of codes, covering dense and passive gasses integrated and instantaneous, normal and accidental conditions. Presently we have 16 of these, in different phases of implementation.



Characterization of urban Madrid, during the first hours of morning. The utilization of NO2 as tracer and the possibility of measurement with remote sensor COSPEC, have been two of the determining keys in this case.

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The method utilized for the prediction of wind field at storage sites is considered demonstrated: it is to say that it is possible and relatively feasible for use in the majority of situations, which occur in Iberic Peninsula. The data for the development and validation of the method was obtained at El Cabril, valley of Madrid and the east coast of Spain. In these situations the major uncertainty are associated to the transition period -- morning and evening.



Meteorological tower, installed at the valley of Madrid for the study of dynamics of the contaminants.

c.) Effect of the atmospheric contaminants on cultivation and vegetation.

The selected contaminant is ozone, because of its elevated potential and relevance to Mediterranean conditions. We have tackled several aspects:

- Studies of cultures in the experimental field: Demonstration of the negative effects of ozone on physiology and productivity of the varieties of kidney beans. Evaluation of the anti-oxidant potential of certain products for arresting these effects. Done in collaboration with the Health Institute Carlos III, and MIGJORN, S.A.

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- Studies of forest species: Determination of the effects of ozone on the growth, chlorophyll and nutrients of pine Carrasco in the project ECOTREE. With the support of CCE.

Visible effects in fiber of *Pinus halepensis*, due to presence of oxidants of photochemical origin in the atmosphere.

- Evaluation of data in the Spanish east wind.

- We documented the existence of visible symptoms of ozone in commercial agricultural watermelon plantations in Tarragona, Castellon and Valencia.

- We demonstrated the effect of ozone on the presence of certain symptoms, visible in natural and semi-natural forest plants of pino carrasco in Tarragona, Castellon, Valencia and Cuenca. In collaboration with the University of New Castle.

- We participated in the expert committee in March, during the convention in Geneva on the long distance transport and border crossing of atmospheric contaminants and the activities COST.

#### BIOLOGICAL EFFECTS OF THE ENVIRONMENTAL AGGRESSORS

This area was supported during 1991 by the following projects.

- Biological effects of environmental aggressors. Molecular and cell biology.
- Industrial risk. Health effects.

This activity produced, during 1990-91, 50 documents, 30 of which were publications and communications.

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Within this area, we participated, for the last several years, in the radiobiological studies, which are integrated in a community project, focused on the radiology induced effects in the hematopoietic system, which is the most sensitive. This work was done with the Institutes of UK, Belgium and Holland, focusing especially on the effects of delays, prenatal exposure and hematological disfunctions.

Another area of actions is centered on the epithelial tissues -- the second most sensitive, and similar to the hematopoietic, is in a constant proliferation and differentiation. It tackles the problem of genetic expression, which are the base of carcinomas. This line focuses on the basic aspects of carcinogens, which understanding is indispensable for the clarification of radio-nuclear induction risk in tumors. A toxic chemical is used in these cases.

On the other hand, the evaluation on the health effects, provoked by the exposure to toxic products, released in the environment, requires the analysis of the existing information of the biologic effects of each product. Without a doubt, the major part in this information is referred to a continuous exposure to relatively low concentration (such as work environment), while for this project, our object is to understand the effects produced in short, medium and long term, as a consequence of exposure during short periods of time to high concentrations of toxic products (such as in a case of an accident.) To this shortage of data, we can add that data, which exists on the experimental animal level. This makes the establishment of dose-response relations, and its extrapolation to human conditions, quite difficult. This activity provides solutions to the problems, encountered in the course of the program of industrial risk.

a. Chemical carcinogens in rat skin.

In collaboration with the Anderson's Cancer Center, University of Texas and the Institute of Biomedical Research CSIC, we identified carotene 8, an important indicator of the progress of this type of tumor. This carotene is not found in the benign tissues, but its synthesis is induced in the carcinomas. A positive correlation exists between its level of expression and the malignancy of the tumor.

Immuno-chemistry with  
peroxidase; localizing  
carotene K13 in  
carcinoma of rat  
skin.

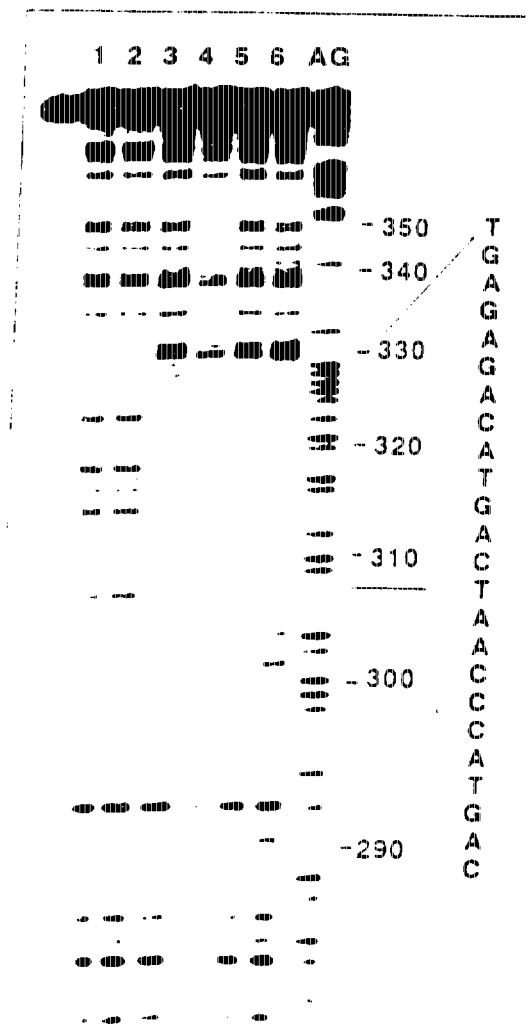


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We determined the diverse lines of cells, representative of different studies of epidermic tumor in progress, which produce and secrete stimulating factors of the hematopoietic difference in SCF, GM-CSF, G-CSF, M-CSF. We researched the possibility that these factors influence the hematopoietic differentiation and the evolution of the live tumor.

b.) Regulation and function of the differential expression of the carotene.

In the work done in determining the regulating mechanism of the genes of the carotene III and IV, as representatives of the stratified epithelium, we identified two new regulating elements - AP-2 RARE - and are studying the interaction of these new elements with the previously identified AP-1, which controls the differential expression of these genes (with help from DGICYT).



Protection against DSA asa 1 of a region of the promoter of carotene K6 indicating presence of element AP-1.

In collaboration with DKFZ, Heidelberg, the Universities of Geneva and Barcelona and Max-Plank Biochemistry Institute of Munich, we proceeded with the production of transgenic rats, carriers of diverse gene constructions. A large part of these transgenics direct the expression of genes of biomedical and bio-technical interest under the control of our promoters of epidermic carotene (with the support of DGICYT).

We presented to DGICYT and EC, the project on the molecular genetics of the epidermic differentiation and its pathology and also the use of this tissue as a vehicle for genetic therapy.

Through the cell trans-infection tests in cultures, we observed that the expression of carotene 10 inhibits progress of the cellular cycle between the G0 and S phases. This represents an important role of this carotene on the post-myototic state of the in vivo cells.

c.) Analysis of the irradiation syndrome and alternatives for correction of the damage.

We initiated work, directed toward the residual character of the hematopoetic damage, induced by radiation of animals. So, we obtained the first hematopoetic disfunction after external radiation with .5 Gy of embryos of 17 days of development.

We obtained relevant conclusion, in respect to the induction radionuclear protection effects by certain polysaturates. These molecules are susceptible to hematopetic stimulae in irradiated animals, which favors the survival index, after radiation with potentially lethal doses. In some cases these molecules are an object for a patent (project done in cooperation with MRC Radiobiology Unit, CEN/SCK, Paterson Institute, TNO-ITR and Complutense University). With the support of CE, OCIDE, ENRESA, CDTI and ANDROMACO.

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d. Behavior of hematopoetic precursors, against different contaminating agents (in collaboration with UAM.)

In this activity we must emphasize:

- Genetic markers of hematopoetic stem: We described a new procedure, based on activation with new inter-lukemics, in collaboration with Immunex and the Genetic Institute, USA, for marking genetically this cell with retro-viral



sectors and follow up in its differentiation, over less than three months (with the support of CE and CICYT).

- Mielosuppression for virus: In this line of research we demonstrated for the first time the imuno-supressing stock of Parvovirus MVMi, which is capable of inhibiting the hematopoetic murine in vitro, infecting cito-toxicallyhemotopoetic pre-cursors and cells of the stem compartment (with the support of CICYT.)

- Genetic interference of virus: In this line of work, we obtained considerable inhibitions of Parvovirus MVMi, which demonstrates an antisensory RNA against a non-structural protein of the virus (with the support of CICYT.)



Purification of hematopoetic precursors, via combination technique of elutration and density gradient. A.) Hematopoetic population control. B.) Population of purified CFU-S<sub>12</sub>

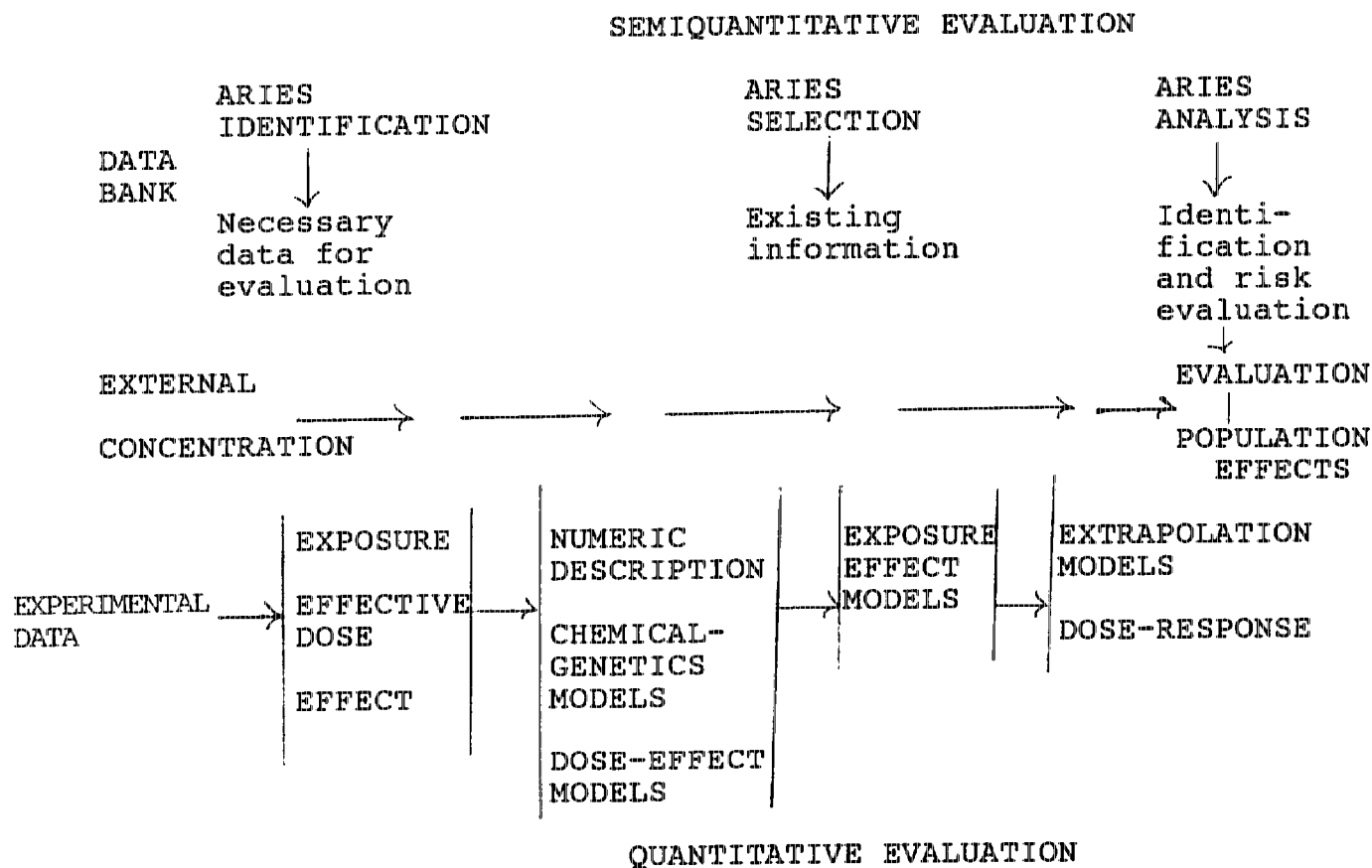
e.) Consequence analysis. Effects on health.

Among the most important aspects of the accomplished during 1991 work, are the following:

- Development of methodology for utilization of simple toxicology indicators in the risk evaluation process.

- Modification of the deposition and pulmonary release of radioactive aerosols with ICRP, for the utilization in the modeling of inhalation of metallic compounds, included in the Guide of CEE 82/501. Development of dynamic pharmaceutical model for the compounds of Beryllium.

• We developed a prototype of the system for semi-quantitative evaluation of the effects on health: ARIES (Application of Industrial risk for evaluation of the effects on health.) It is executable and includes numeric data and sufficient information for accomplishing the evaluation process for approximately 10% of the products, included in the Guide CE 82/501.



Method for evaluation of toxic products on the health.

f. Action committees and work groups.

• Participation as experts in EULEP, Biotechnology program of CE and program for promotion of knowledge.

3

PUBLICATIONS							
	Technical support -	Internal radiology control	External radiology control	Geo-chemistry environmental impact	Conventional environment	Molecular and cell- biology	
Articles in Magazines	--	--	3	2	5	7	17
Memos, Technical notes.	20	40	26	17	33	24	160
Memos, CIEMAT	---	---	---	1	---	---	1
Communications	1	5	5	9	8	22	50
Books	---	---	2	2	---	---	4
Thesis	---	---	1	---	---	1	2
Patents	---	---	---	---	---	1	1

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 AGREEMENTS SIGNED DURING 1991  
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ORGANS OR  
 ENTERPRISES  
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External radiology control  
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- Activities of radiology vigilance in the Villa of Madrid Madrid Council
- Plan for environmental radiology vigilance ANA
- Analysis of samples of control of PVRA of the Vandellos nuclear station HIFRENSA
- Analytical measurements Campaign for radioactivity measurements REVIRA. CSN
- Transfer of radionuclides, released in an accident in the agricultural system and development of corrective actions for reduction of the contamination of food products (TARRAS) UB
- Utilization of software COSYMA CE
- Migration of radionuclides in the Mediterranean eco-system. UB
- Comparison of method for the demonstration of the long term safety of toxic, dangerous and radioactive waste INTERA
- BIOMOVIS-2 AECB, AECL, SSI,  
ENRESA
- Revision of the methods for evaluation of radiology impact of routine atmospheric discharges of the EC nuclear stations NRPB
- Participation of CIEMAT in the executive committee of the cooperative program IEA, on I+D, in relation to the CO2 and other gasses in the winter pastures. OCICARBON
- Implementing an agreement for a cooperative program on technology, related to greenhouse gasses, derived from fossil fuel use. DEMR, DEA, MTI,  
ENEL, NEDO,  
NOVEM, GKN,  
NUTEK, SSE, DoE

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## Geo-chemistry and environmental impact.

- Measurements of radon in houses. UAB
- Contamination of sources by resuspended activity background. CHECIR-4. CE  
UKAEA  
CEA  
GSF
- Evaluation and development of decontamination strategies for a range of environmental situations CE  
CEA  
NEB  
RML
- Integrated European planning of experiments of symmetry of the program RESSAC. CE
- Collaboration, extraction and transport of a typical monolithic Mediterranean soil for the program EROESSAC. UB

## Conventional environment.

- Regional cycles in the Mediterranean media. RECAPMA. CICYT
- Interaction between contamination of the air, climatic and nutritional factors in the physiology of the conifers. ECOTREE-1. CE  
UNANCY  
UESSEN  
UNEW  
UGEN  
URLS  
ULANC

## Molecular and cellular biology

- Regulation and function of the differential expression of cito-carotenes. Use of the regulating elements of genes to the direct ectopic expression of other genes or epitelis. CICYT

## PROGRAM OF ENVIRONMENTAL TECHNOLOGY

This is a line of work of horizontal activities, to which contribute 4 CIEMAT Institutes (IER, IMA, ITN and DT) and which is coordinated within the Directorate of IMA.

This work was supported during 1991 by 7 CIEMAT projects:

- Combustion and incineration of waste in fluidized bed furnace. ITN.
- Treatment of liquid effluents. ITN.
- Environmental analytical chemistry. DT.
- Development of instrumentation and analysis for environmental optimization of industry. IMA, DT.
- Environmental biotechnology. IER, IMA.
- Application of the solar radiation for illumination of toxic and dangerous waste. IER.
- Mitigation techniques of industrial contamination of aquatic media and recuperation of the contaminated soils. ITN.

The line of work includes the related activities to clean combustion of coal.

The activities produced 77 documents, 16 of which were publications or communications.

It is known that the energy sector was the first industrial sector to be submitted to the environmental problem stress, and within it the nuclear sector in particular. This contributed to the major developments of methods, techniques and mentality in relation to the environmental subjects in the world of energy production.

The development of methodologies, techniques etc., although done with a concrete objective, generally exceed the area for which they were established, thus resulting in more ample applications.

Both realities present in the life of CIEMAT, have put the Center in a position to develop the program of environmental technology in the appropriate moment.

The orientation and the inspiration of the energy field is clear, and so are the measures and experiences which support these. Thus, the program is undertaken without limitations, or with other words, fully supporting the implementation of environmental techniques in industry.

The contents of the program, which must be progressively improved and complemented, are a result of the analysis of the interaction between potential capacity of CIEMAT, the industrial environmental problems and the availability of industrial agents for tackling certain I+D+D subjects. And so, the program doesn't cover all the areas of environmental and energy interest, but takes a step toward problems, which by its conventional (non-radiology) character are closer to the industrial world.

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The products, which we foresee to be produced in this program are:

- Increase of CIEMAT's capacity, for providing services of I+D and to the enterprises of the environmental sector, or other enterprises, who adopt the environmental norms.

- Conceptual demonstration and development of prevention techniques (clean-up, measurements etc.)

a.) Technical assistance, services and demonstration in collaboration with the combustion, incineration and wet treatment industry.

- Definition of the conditions for attack of minerals, originating from the district of Gallineiro, and preparation of solutions for the separation by

extraction with solvent under a contract with ERCROS.

- We finished a demonstrative study in the wash of Botan of HUNOSA.
- We started a study for separation of rare earths, by liquid-liquid extraction with the help of CICYT.
- We completed tests in fluidized bed furnaces with black lignites. Study of reactivity of ashes, and effect of the porosity, and liquid dynamics study in cold, with the support of CICYT.
- Establishing and initiating the agreement with ENDESA and SCAP, EUROPA, S.A. for the optimization of combustion and the environmental impact of fluidized bed furnaces, utilizing control systems, adopting CIEMAT's experience in this field.
- Collaboration with NEDESA, characterization of the fuels and absorption, for the 175 MW plant of Teruel, the Thermal Station at Almeria and the plant at Escatron.
- Initiation of environmental behavior of ashes, originating from combustion of circulating fluidized bed furnaces.
- Establishing an agreement for collaboration with the International Energy Agency in the area of fluidized bed combustion.
- Initiating a fluidized bed combustion of used oil, by a request from the Autonomous Community of Madrid.
- Preparation and initiation of a fluidized bed combustion in a pilot plant and demonstration of ash waste in the industry and of hides, in collaboration with INTESCOP, and subsidized by the program MEDSPA of CE and the program PITMA of the Ministry of Industry, Commerce and Tourism.



b.) Development of analytical chemistry of interest to the environmental-industry projects.

- In atmospheric samples we tackled the following areas: particles in filters, volatile aliphatic and aromatic hydrocarbons of anthropogenic order, aliphatic and aromatic poly-cyclics, and volatiles of bio-genic origin.

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- The expansion of the analytical capacity in aquatic samples was done in: aromatic poly-cyclics in continental waters, phenols in waters, pesticides in surface waters, heavy metals in sea water and industrial effluents. Participation in the project "Environmental studies in the Mediterranean basin".

- As far as soil and vegetation is concerned, we progressed in: heavy metals in vegetation, chemical specialization, chemical assistance in studies on vegetation and ozone content in these.

- We analyzed 2500 samples, or a total of 47000 measurements.

c.) Studies for the optimization and instrumentation.

- We designed and operate an information application for calculation of CO<sub>2</sub> emissions in Spain, beginning with burning of fossil fuel in different energy, industrial, transport and household sectors.

- We revised the feasibility on the technological solution for the retention of gasses, related to the winter pasture effect "CO<sub>2</sub> disposal" with British coal. DMT and CERCHAR, with the support of CCE. We acted as the Spanish agents in the agreement for implementation of the AIE-OCDE on the same subject (with the support of OCIDE, OCICARBON.)

- We established the collaboration with the State Secretariat of Industry for the management of the industrial program and environmental technology. Our role was focused on the support, evaluation and follow-up of the I+D projects.

- We concluded, with a positive result , the feasibility analysis for the development of opto-electronic sensors for gasses in chimneys and industrial conduits, in collaboration with UPM.

- We initiated technical support action in the context of the Geneva Convention on the long distance and trans-border transport of atmospheric contaminants. In particular we analyze the critical load maps of the Spanish territory.

#### d.) Environmental biotechnology

- We concluded the study of perspectives for biotechnology, applied in the purification of waste, determining the interest of each one of the identified development direction at CIEMAT, on the basis of the importance of its applications and of the existing capacity.

- We initiated a project of the effects of RSU on air, water and vegetation at five waste disposal sites of CAM, with the objective to arrive at conclusions on the technology and forms of management, in order to minimize the environmental impact of this technology.

- We worked on the compost production projects for agricultural use, starting with sweet sorghum, project CE-JOULE, and from straw, in mixtures of other wastes and residues, such as that from the cattle industry, and other sludges.

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- We initiated a project for biological purification of residual waters in the paper industry, project CE-ECLAIR. The work during this year was focused on the selection of micro-organisms, most appropriate for the function of this process.

e.) Application of solar radiation for elimination of toxic and dangerous waste.

We completed, with good results, under the project for solar detoxification at the installation at Almeria, the first tests for degradation of contaminants dissolved in water, included within the plan of Access and Large Installations of CE.

- We started two solar simulator installations, which permit the analysis on a lab scale, of the detoxification of liquid and gas currents at low and high solar concentrations.

f.) Techniques of mitigation of contamination of soils and aquatic media.

We tackled the conceptual analysis of the procedures and technologies, available for correction of the impact on the soil-water system

DIRECTORATE OF

TECHNOLOGY

(top to bottom - RIGHT MOST COLUMN ONLY LEGIBLE)

ADVANCED SENSOR TECHNOLOGY

INFORMATION ENGINEERING

APPLICATIONS PROGRAMS

MANAGEMENT AND OPERATION

ENGINEERING

ELECTRONICS

WORKSHOPS

MAINTENANCE

CHEMISTRY

ISOTOPES

GEOLOGY

REMAINING TEXT

ILLEGIBLE

**TECHNOLOGY OFFICE**

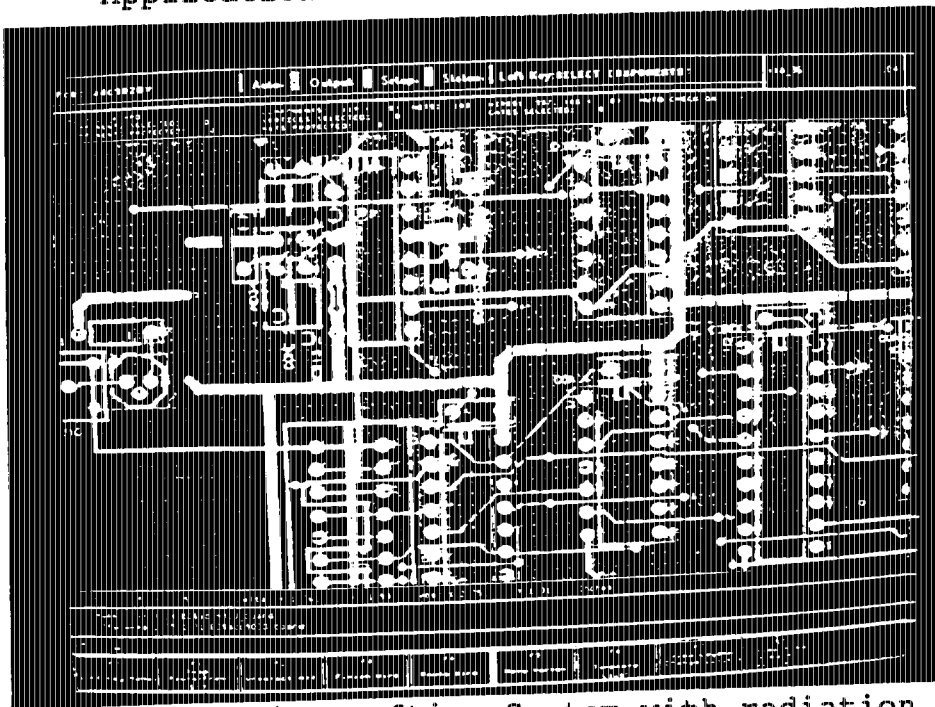
In order for CIEMAT to operate in its main areas of activity it is necessary to have a technological infrastructure which guarantees it the availability of the most advanced methods, so that its R & D effort is competitive. This is the main purpose of the Technology Office.

Additionally, the Technology Office undertakes research and development, both to develop new products in collaboration with the industrial sector, as well as in performing and improving its own capabilities, always trying to incorporate new technologies into its research projects.

**AREAS OF ACTIVITY**

Advanced Sensor Technology

- Applications of new semiconducting materials



Printed Circuit Drafting System with radiation sensor circuit.

### Computing and Microelectronics

- Scientific programming and modelling
- Automation and robotics
- Management Information Services

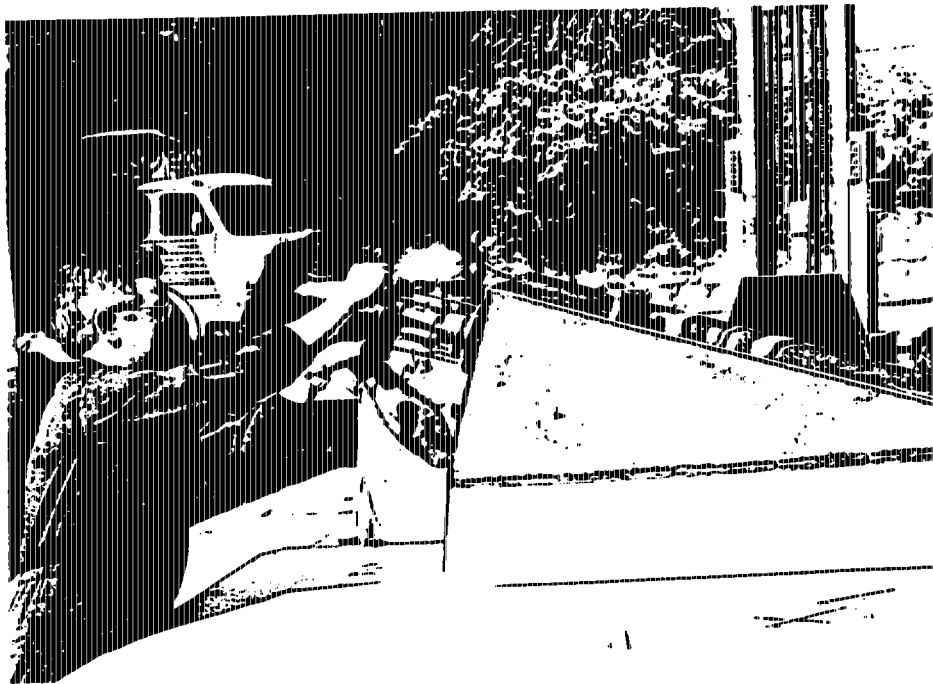
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### Chemical and Geological Technology

- Analytic chemistry
- Development of radioisotopy
- Stratigraphy and minerology
- Geologic techniques for the study of the migration of radionuclides in natural environments

### Engineering and manufacture

- Prototype design engineering, fabrication and assembly
- Nuclear and conventional electricity
- Build and assemble experimental facilities
- Maintain the general infrastructure of the Madrid and Soria centers.



Assembly of photomultiplier in Cherenkov effect detector, built by the General Workshop for the WA94 CERN experiment.

## THE MAIN FACILITIES

### Advances densor Technology

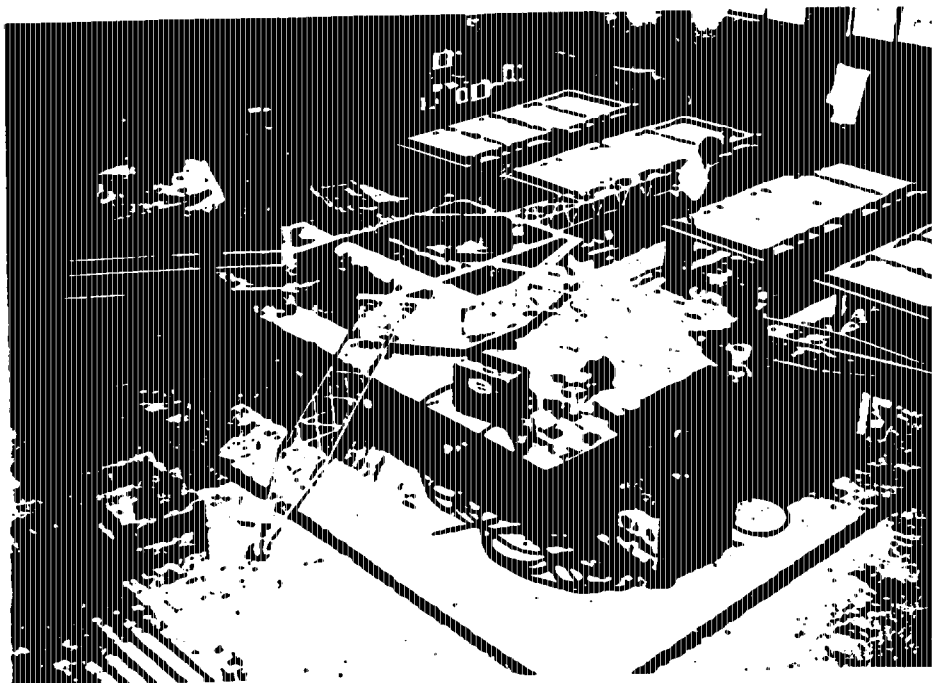
- Integrated circuit design lab

### Computing

- Scientific programming IBM 3090/150 with vector accelerator module
- Administration IBM 4381/4
- Office automation VAXnet 785/2X 3850
- LAN ETHERNET
- External communications IRIS, FAENET, EARN
- Robotics lab

### Engineering and fabrication

- Nuclear electronics lab
- Analog and digital electronics lab
- Engineering bureau
- Fabrication and assembly workshops



Construction in General Workshop of the tensioned reflective membrane heliostat, diam. 9 m., 60 sq. m active surface, for the PSA research program.



Chemical and geological technology

- Labs for analytic chemistry using Atomic Absorption Spectrography, Plasma Spectrography, Fluoresence and X-ray diffraction, Spectrophotometry, Humidity Path, Liquid Chromatography, Ionic Chromatography, Electroanalysis, Fluorometry, Infrared Spectrometry, Differential Thermal Analysis and Thermogravimetry, Mass Spectrography and Element Analysis.
- Labs of Nuclear Pharmacology and Radioimunoanalysis and Isotope-marked Molecules
- Radiochemistry and Irradiated Chemistry Labs
- Petrography, Mineralogy and Metals Lab
- Soil mechanics lab
- Hydrochemistry Lab
- Experimental facility in the "Berrocal" mine

#### **PROJECTS AND ACTIVITIES**

Among the R & D projects for 1991, the following stand out:

- Advanced sensor technology
  - Industrial automation and Robotics
  - Development of radiation monitors and special electronic equipment.
  - Characterization of materials by their radionuclide retention properties
  - Applications of isotopes and chemistry under irradiation
- To these must be added the activity of infrastructure support, which can be summarized in the following areas:
- Computing and microelectronics
  - Support by chemical and minerological research
  - Support by engineering and fabrication

#### **ADVANCED SENSOR TECHNOLOGY**

With the rapid development of technology, it is possible to develop a great range of sensors with a high degree of sophistication, which permit signals imperceptible to the senses to be measured.

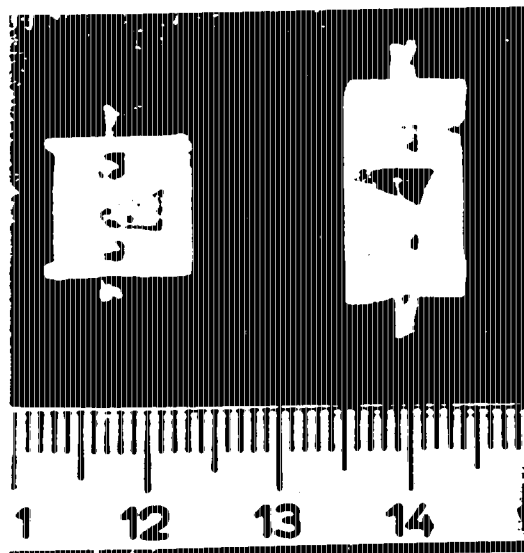
The CIEMAT research into sensors involves several technologies.

- Application of new materials
- Microelectronics
- Artificial intelligence and expert systems
- Artificial vision

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The radiation vision system aims at developing a compact, portable system, capable of forming the image of a diffuse radiation source. In essence, it is similar to a video camera which works in the range of ionizing radiation.

CIEMAT is working on the development of special light sensors, using a new generation of semiconducting materials. Involved in this activity are many projects related to the use of silicon based photodetectors in environments which are highly radioactive. In particular, it is taking an active role in a project, financed by the EC, which aims to find new CCD structures to construct video cameras which will tolerate high doses of radiation.



Monocrystalline  $\text{HgI}_2$  radiation microdetectors.

#### Resources

- Personnel - Degreed 11.3

(Continued on next page)

#### Assistants 6.9

- Internal Budget (Million Ptas.) 46.0
- Outside funding (Million Ptas.) 53.0

#### Results

- Lab spectometry prototype
- Development of a radiation monitor with new semi-conducting materials
- Trial X-ray collimator mask
- Growth and study of sheets of  $\text{HgI}_2$
- Theoretical and experimental study of the behavior of CCDs under radiation

#### Collaborating institutions

- Universidad Autonoma de Madrid
- Information Faculty de Madrid
- OCIDE
- AMYS
- ENRESA
- HIDROELECTRICA

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- CICYT
- EC
- THOMPSON(France)
- SOFRETEC(France)

#### INDUSTRIAL AUTOMATION AND ROBOTICS

This project has the goal of carrying out tasks in the field of automation of facilities and in the design of robotic mechanisms capable of working in dangerous surroundings. These services are offered to the different CIEMAT Institutes and also to outside companies developing industrial and experimental automation, both in the design of the equipment and in building it. Special instrumentation for the study of transducers and sensors using the treatment and representation of electronic signals. Robotics in the areas of analysis electronic design control software and. This last effort is

made in active collaboration with the CIEMAT General Workshop in design and fabrication of robotic equipment.

#### Resources

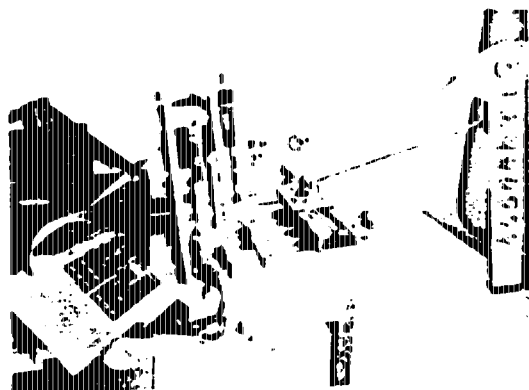
- Personnel            Degreed        6.0  
                         Assistants 9.7
- Internal Funding            3.8 Mil. Ptas.
- Outside funding            8.8 Mil. Ptas.

#### Results

- Development and fabrication of a robotic hand
- Development of electronics and mechanical fabrication of a walking robot
- Development of special instrumentation for measuring atmospheric contaminants
- Creation of new instrumentation based on amorphous silicon sensors for applications in Medicine, Environment, Crystallography and Nuclear Safety.

#### Collaborators

- ESSA
- Instituto de Automatica Industrial (Industrial Automation Institute)
- CERN



Experimental assembly of body and one foot of RIMHO robot.

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#### DEVELOPMENT OF RADIATION MONITORS AND SPECIAL ELECTRONICS

New equipment and electronic systems are developed for the detection and measurement of ionizing radiation, in

cooperation with businesses and research facilities in Spain. Also, special electronic equipment is developed to meet the needs of CIEMAT research.

#### Resources

- Personnel:            Degreed     4.3  
                         Assistant 9.4
- Internal funds            2.2 Mil. Ptas.
- Outside funds            0.6 Mil. Ptas.

#### Results

- A new method of measuring Radon has been developed which itself measures the effectiveness of the detectors being used. A laboratory prototype has been developed and an ionization chamber for absolute measurements of alpha emitters.
- The cooperation with the Defense Ministry has continued, developing equipment for protecting its units from radiation, both on land and sea. The MRM-2 monitor and the dosimeter based on luminescence, model LDT-1N.

#### Collaborators

- Direccion General de Armamento (DGAM) General Director of Armaments
- Direccion General de Construcciones Navales Militares (DIC) General Director for Military Naval Construction
- ARIES, S.A.
- EISA

### CHARACTERIZATION OF MATERIALS BY RADIONUCLIDE RETENTION

The goal of this project is the investigation, development and application of geological and chemical methods and techniques to determine the conditions governing migration of radionuclides in natural and artificial barrier materials, with a view to guaranteeing their containment, and avoiding their incorporation into the biologic cycle.

#### Resources

- Personnel:            Degreed     17.4



Adjusting and set up of MRM-2  
radiation monitor by DGAM.

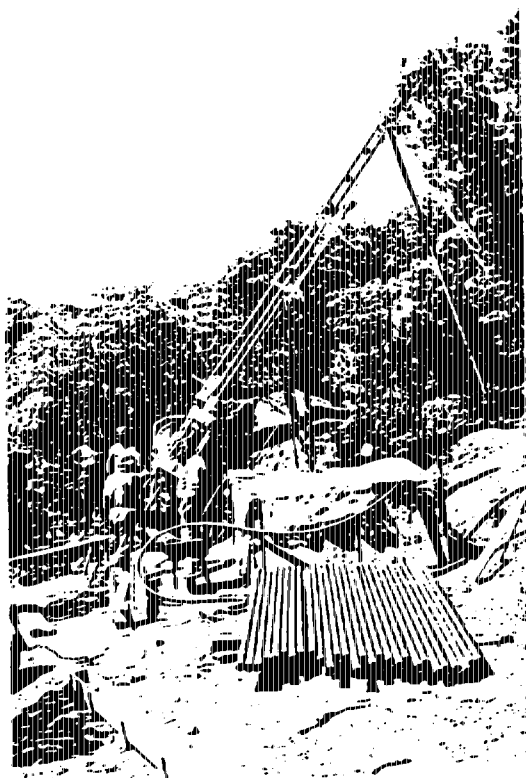
Assistants 25.3

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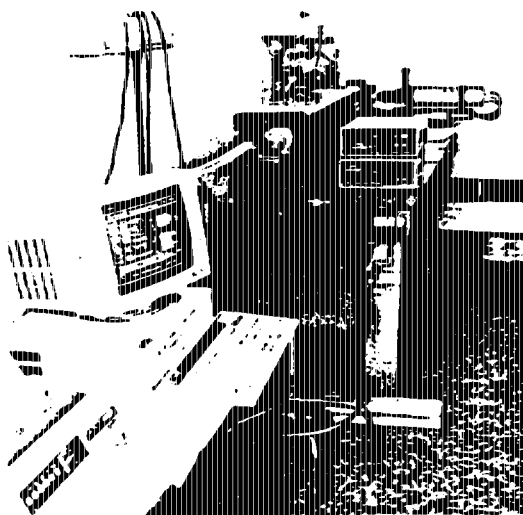
- Investment 172.6 Mil. Ptas.
- Outside Income 357. Mil Ptas.

#### Results

- Signing of a new agreement for cooperative research and investigation between CIEMAT and ENRESA in the field of radionuclide migration and the behavior of natural and artificial barriers in the face of this migration, which foresees the development of four important projects in the period 1991-94, of which two are partially funded by the EC.
- Study of interstitial water in the Andujar aquifer, and completion of the hydrochemical study of El Cabril.
- Design and construction of thermohydraulic and hydrochemical test cells.
- Studies of migration in the experimental 'El Berrocal' station, with the completion of 5 boreholes, taking of samples and concentrations and a study of the colloid material; measurements of geophysical evidence and petrology.
- Study of colloidal fractions and of the isotopic



Drilling a borehole inclined at  $30^\circ$  for examination of the mineralized layer at the 'El Berrocal' experimental station.



Spectrography equipment using photocorrelation to determine the colloid particle size.

equilibrium of uranium, using a colloid transport model.

- In Jerez de la Frontera, Spain, the Third International Conference on Chemistry and Migration Behavior of Actinides

and Fission Products in the Geosphere was held from 21-25 Oct, 1991, with researchers from 20 countries attending, and some 200 papers being presented. The conference was organized and supported by CIEMAT in cooperation with the International Steering Committee of the conference. It was financed by ENRESA and the EC.

#### Collaboration

- National Wastes Enterprise (ENRESA)
- Ispra Joint Research Center (Italy)
- Commissariat a l' Energie Atomique (CEA) (European AEC)
- European Community (COCO, MIRAGE)
- Harwell Laboratory (U.K.)

#### ISOTOPE APPLICATIONS AND CHEMISTRY UNDER IRRADIATION

Their goal is to make available in Spain, through agreements for cooperation with public research bodies, universities and businesses, the technical capacity and facilities necessary to carry out research and to provide service in the field of radioactive tracers in Pharmacy, Medicine, Health and Industry.

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This involves four fundamental areas of activity:

- Pharmacokinetics: Performing studies of the metabolization and pharmacokinetics of new drugs.
- Radioimmunoanalysis: Development of procedures and preparation of radioimmunoanalysis kits.
- Marked molecules: Synthesis of radiopharmaceutics and organic compounds in general which are marked with radioactive tracers.
- Radiochemistry: Radiopharmaceutic quality control.

#### Resources

- Personnel: Degreed 13.5
- Assistants 11.5
- Investment 12.2 Mil Ptas.
- Outside funds 13.4 Mil Ptas.

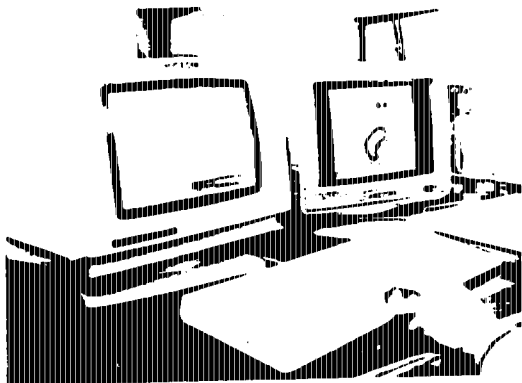
#### Activities



- Application of GLP quality control system to all the pharmacokinetic activities of CIEMAT.
- Investigations on the role of metallic ions in the process of heavy metal poisoning have produced a doctoral thesis and two papers presented to congresses.
- Collaboration with the JUSTESA IMAGEN, S.A. research center for the development of new therapeutic molecules and diagnosis by imaging.
- Developments of RIA kits for the detection of metallic ions and diethylstilbesterol in meat.
- Development of a procedure of synthesizing Pipotiazine marked with C 14, using Cl-Br-propane as a base, in collaboration with RHONE-POULENC PHARMA, S.A..

#### Collaboration

- Ministry of Health and Consumer Affairs
- Pharmacy Department, University of Complutense
- JUSTA IMAGEN, S.A. research center
- RHONE-POULENC FARMA



Radioisotopes in use: Autoradiogram analysis.

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#### COMPUTING

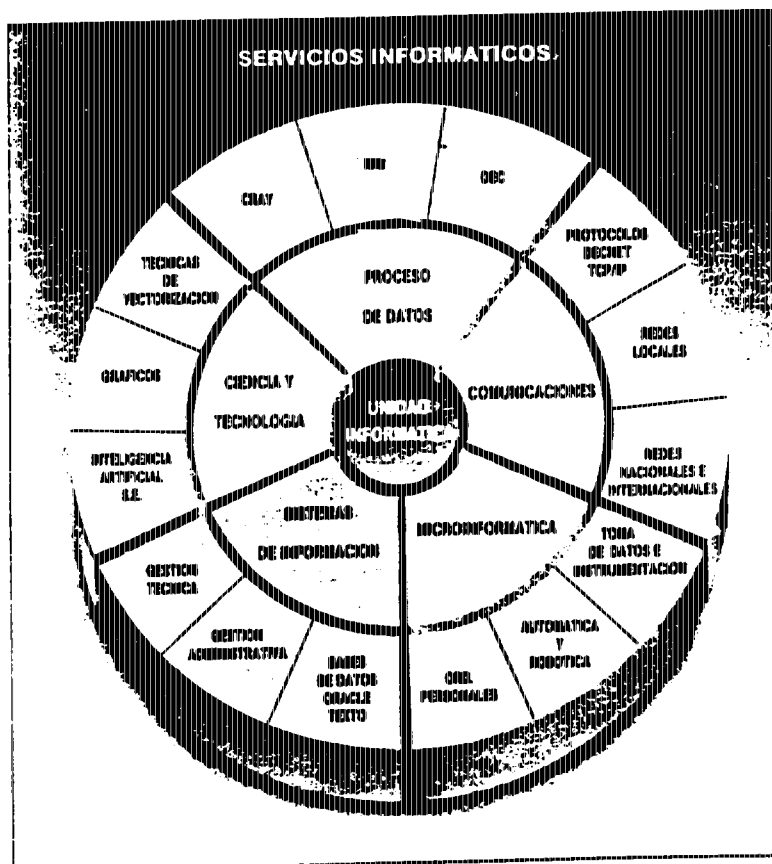
The Informatics Group is committed to supporting the use of information technology and informatics communication which

are needed by the Agency for satisfactory performance of the projects it is involved in.

The informatics architecture is installed, maintained and operated to facilitate scientific calculation and data processing with the goals of homogeneity and compatibility.

There is participation in the National Science Plan search for definitive technology and the provision of information services to the scientific community.

Additionally, the institutional information is developed and supported as a strategic tool in Agency management and operation.



### Information Services

#### [OUTER CIRCLE]

IBM  
DEC  
TCP/Procedures  
LANs  
Data gathering  
Automation and robotics  
Personnel  
Oracle D.B.  
Administrative Management  
Technical Management  
A.I.  
Graphics  
Vectorization techniques  
CRAY

#### [INNER CIRCLE]

Data Processing  
Communications  
Microinformatics  
Information systems  
Science and Technology

#### [CENTER]

Information Unit

### Resources

- Personnel:	Degreed	22.4
	Assistant	37.0

- Investment                    244.2 Mil. Ptas.
- Outside funding            89.6 Mil Ptas.

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### Activities

- Installation of a VAX 6410 computer with a DEC multiprocessor cluster. A Cray XMS has also been installed for fusion calculations and a Cyber 830 from Control Data for running nuclear programs.
- Implementtion of the standard communications protocol TCP/P to enhance internal and external connectivity.
- Technical and organizational management together with the IRIS program of the FAECAD network whose range includes all the regional users of DECNET. The scientific community is still provided with access to the Cray computer at CASA (Spanish National Aerospace).
- Installation of accounting software which gives the MIS department new capabilities.
- Development in the area of technical management of various projects applications, among them participaton in the STEP-THOMID project of the European Community, updating of the Bibliographic Bulletin, the IEE system of handling medical examinations and course management.
- Applications of scientific information technology with the development of graphics interfaces, solving the 'master equation' for the changes of a system of stochastic variables, and verification of scientific vectorization coding.
- Preparation and presentation of the model expert system for analysis and evaluation of the contamination produced by the escape of conventional toxic industrial substances as part of the Industrial Hazards program.

### Collaboration

- CICYT
- FUNDESCO
- ETSIM-UPM
- UCM

- CSIC
- CERN
- HALDEN

#### CHEMICAL RESERCH SUPPORT

Performance of analytic research, technical assistance and provision of services attendant to the needs of the institutes and offices of CIEMAT and of industry or national research centers, leading to collaboration with them.

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Participation in comparative international studies on the environment.

Additionally, the application of chemical measurement is being perfected as an aid to handling analytic information, as well as the realization of methods and incorporation on new technologies as part of these projects and activities, which itself requires a considerable research effort.

#### Resources

- |                   |                |      |
|-------------------|----------------|------|
| - Personnel       | Degreed        | 9.2  |
|                   | Assistant      | 10.8 |
| - Investment      | 23.2 Mil Ptas. |      |
| - Outside funding | 2.9 Mil Ptas.  |      |

#### Activities

-Analytic chemistry

- Research in refractive and structural materials for fusion applications

- Research into rare earths which have given rise to development of a method for separation of thorium, and the analysis of concentrations using ICP. The CICYT has approved a project on these lines.

- Technical assistance for the characterization of filler materials and artificial barriers.

- Development of a spectographic method for the detection of boron in coal.

- It has carried out geochronology studies of the Sierra de Grados and of the Cabeza de Araya batholith.

- Environmental analytic chemistry
- Research on spectral interference for analysis of particulate materials in filters. Study has begun of environmental samples provided by AMYS (UNESA).
- Study on the detection of volatile organic compounds (VOC) in the air.
- Studies on the effects of ozone and the testing for various types of chemicals in air, as part of the RECAPMA project. Technical assistance has been provided to the MECAPIP project.
- Characterization and testing for phenol and polycyclic aromatic hydrocarbons in surface and subterranean water.



Gas chromatography using a selective molecular mass detector used in environmental research.

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- Detection in continental waters of the six most representative polychlorobiphenols.
- Development of methodology applicable to the processes of combustion and continuous ion exchange, with environmental applications.
- Typing of  $\text{Cr}^{3+}$  and  $\text{Cr}^{6+}$  in continental and marine waters

using ICP.

- The study of urban solid waste dumps has been given special attention. Two scientific papers have resulted and been presented to international congresses.
- Participation in the EC project on the control of pollution in the Mediterranean basin and on interdisciplinary studies of the detection of heavy metals in water and vegetables, as part of the BRC (Brussels) program of the JRC(Ispra) and the Pallanza Hydrobiological Institute (Italy).
- Analysis of 1967 samples, with a total of 37,656 assays, which were involved in 13 different projects of CIEMAT included in the Program of Environmental Technology (Programa Horizontal de Tecnologia Ambiental).

#### Collaboration

- National Waste Enterprise (ENRESA)
- UNIESA
- TECHNATOM
- ENDESA
- ADARO
- Universities
- Research centers

#### ENGINEERING AND FABRICATION SUPPORT

The main goal is to provide technological support in the area of engineering and fabrication of experimental prototypes required for CIEMAT research.

The Unit is also responsible for improving and maintaining the CIEMAT infrastructure.

#### Resources

- Personnel            Degreed    18  
                         Assistants    97
- Internal funding    58.6 Mil Ptas.

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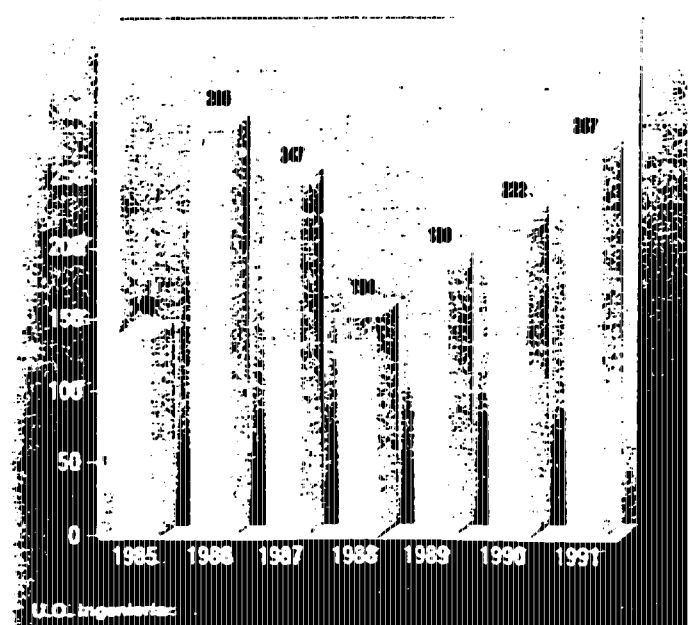
#### Activities

- Mechanical engineering
- In collaboration with the Solar Division of the Institute

of Renewable Energy Sources (Instituto de Energias Renovables), development of thermal tests for elements (nosecone and leading edges) of the Hermes shuttle, at the Almeria Solar Platform. The program was begun in 1991 and will continue through the 90's until the shuttle is completed.

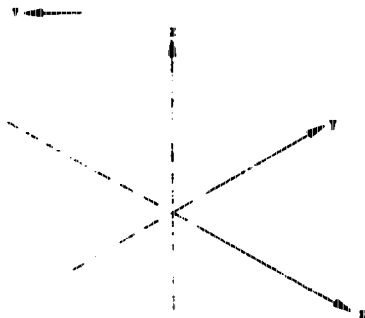
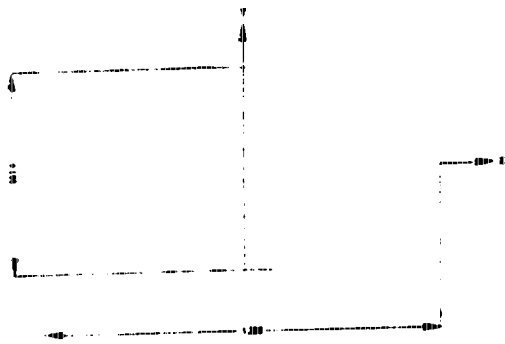
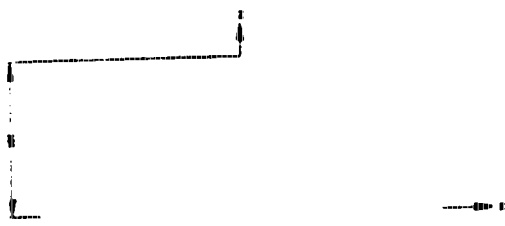
Thermal analysis was performing defining the energy loads in the trial, the design of the cooling of surfaces near the elements being tested by solar irradiation, the design of the measuring system for deformation occurring during the trial, the design of the support and handling mechanism for test pieces and the remodelling of the tower, adapting the existing location to the test conditions.

The model for moulding the nosecone cover, which will be used in validating the tests and prototype deformation and temperature measurement systems.



- For the development program in industrial robotics and electronics the mechanical elements of a prototype 4-legged robot were designed and built, with the ability to move across surfaces which are not flat carrying a 25 kg payload.





CAN and NC machining of the mould for the Hermes nosecone.

- For the fusion program a thorsatron chamber TJ1-UP was constructed, and work continues on the poloidal coils.

-In the area of civil engineering

- Projects in new construction and remodelling, to the value of 75 Mil Ptas have been completed, with projects worth some 267 Mil Ptas. currently underway.

-In the field of building, road, habitation and conventional networks and facilities maintenance /145

- 2004 work orders were filled for corrective and preventive maintenance, with an increase on the year of 11.5%.

- Remodelling was carried out in:

-Exterior illumination, with bulb changes

-Voltage changed from 220 to 380

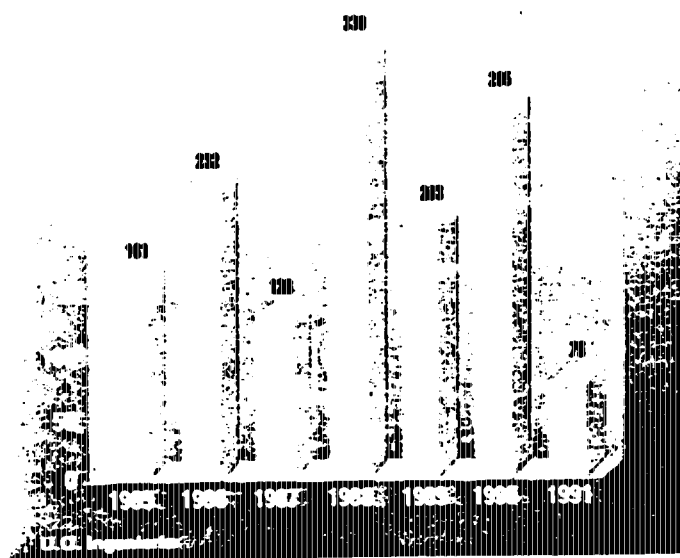
-Telecommunications infrastructure installation

-Telephone network enlarged

-A start in automating control of boiler rooms and air conditioning plant

-Rehabilitation of woods and meadows

- 9 major remodelling works were performed for the Administration, to the value of 43.4 Mil Ptas.



## PUBLICATIONS

	ADVANCED SENSOR TECHNOLOGY	INFORMATICS AND MICRO- ELECTRONICS	ENGINEERING AND FABRICATION	CHEMICAL & GEOLOGICAL TECHNIQUES	TOT.
National Publications	—	1	—	1	2
Foreign Publications	3	—	—	—	3
CIEMAT reports	—	—	1	3	4
Conference papers	9	1	—	8	18
Books	—	—	—	2	2
TECHNICAL DOCUMENTATION	2	—	—	1	3
EC reports	2	—	—	33	35
Industrial reports	—	—	1	32	33
National patents	2	—	—	—	2
Proceedings	—	—	—	5	5
Safety bulletin	—	—	—	14	14
Theses	—	—	—	1	1
Quality Control Report	—	—	—	11	11

## AGREEMENTS SIGNED DURING 1991

ORGANIZATION OR  
FIRM

## WASTE TECHNOLOGY

- Environmental study of colloids and compounds in granitic ground water. Collaborative agreement. New Jersey
- Characterization and validation of the processes of migration of radionuclides occurring naturally in fissured granitic rock. (El Berrocal). EURATOM
- Research and development of technology in the area of the migration of radionuclides and the behavior of natural and artificial barriers regarding migration. Supp. V. ENRESA

- Modelling and validation of the thermo-hydraulic, mechanical, and geochemical behavior of clay barriers.	EURATOM ENRESA CEN/SCK
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#### CHEMISTRY AND ISOTOPES

- Research environmental degradation resulting from dumping urban solid waste in five dumps of the Commune of Madrid.	UAM
- Research of the separation of rare earths using liquid-liquid extraction.	CICYT

#### TECHNICAL SUPPORT

- Management and operation of access to the Cray supercomputer.	FUNDESCO
- Reciprocal provision of information services.	UPM
- Funding for traffic on the Atlas Energies physical network (FAENET)	CICYT
- Management of the IRIS net based on the DECNET architecture.	FUNDESCO

#### INDUSTRIAL AUTOMATION AND ELECTRONICS

- Growth of Mercuric iodide monocrystals in volume, for use in radiation sensors. Project expansion.	UAM
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**INSTITUTE OF  
ENERGY RESEARCH**



## **INSTITUTE OF ENERGY RESEARCH**

From its creation in 1965, the Institute of Energy Research at CIEMAT has been focussed on the concern of this Agency for the tasks of continuing training and development in those areas involving its research activity.

The themes marking the larger part of CIEMAT activity, energy and the environment, and on which the Energy Research Institute focusses nearly all of its attention, compose at the present time one of the major challenges for our society. To pursue the goal of making "sustained development" possible is, today, one of the major occupations of the science and technological communities and the role training must play in this work is quite clear.

Additionally, our country faces the rather difficult task of fully incorporating itself into the European socioeconomic context, which is undoubtedly more advanced in many areas, a fact which lends special weight to the preparations made in all sectors, so that Spain will be able to achieve competitiveness in the Unified European Market, that is rapidly appearing.

These two circumstances, together with the developments that CIEMAT has produced during its labours, justify the increased interest shown in recent years in the courses offered by the Institute of Energy Studies(IEE).

The position of the IEE within an applied research organization such as CIEMAT, which is making a huge effort to effectively link itself with the industrial sector and with other research groups carrying on related work, permits it to focus on training from a point of view intermediate between the scientific and rather more theoretical one, which is usually held by groups doing basic research, and the search for quick and slick solutions which is usually demanded in industry, but it is dominated by neither viewpoint, so that its activities usually find a balance between the two.

All this is possible thanks to the cooperation of all CIEMAT researchers and of all the other personnel involved.

As in years past, the concrete goal of the institute continues to be to promote, organize and develop training activities in the fields related to the research activities of CIEMAT, to bring into being and perfect the abilities of its personnel, and to create a connection between the rest of the scientific and industrial community. To achieve this goal the IEE has been able to rely on the following in 1991:

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Human resources

- Higher and intermediate degrees 10
- Assistants 15

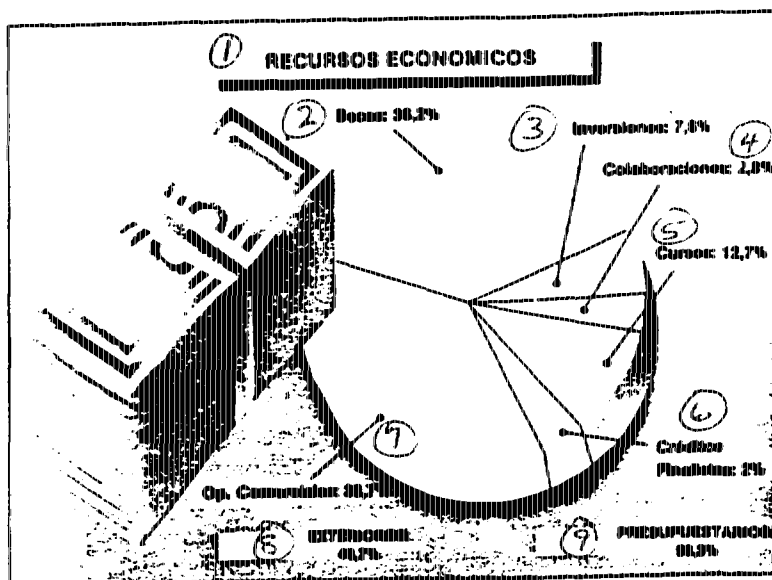
Economic resources

- Budgeted (Mil Ptas.)
  - Internal funds 13.5
  - Scholarships & Grants 64.0
  - Collaboration 5.0
  - Courses and Seminars 22.3
- External funding
  - Credits outstanding 3.6
  - Commercial operations 68.3

Arrangements and agreements entered into:

- INSALUD (Radiological Protection Training Program for INSALUD personnel)
- ENRESA (Courses on Handling of Radioactive Waste and the Training Program in Energy and the Environment)
- UNESA (Courses in the areas of Energy and the Environment)
- SGMA(MOPT) (Courses on the Environment)
- Castille and Leon Society (A course on Biomass and another on Field Geochemistry)
- CSN (Collaboration in Qualifying Radioactive Facility Operators)
- UAM (Joint organization and production of a Master Course in Nuclear Energy)





Key: (clockwise from top)

(1) Economic Resources; (2) Grants; (3) Internal funding;  
 (4) Collaboration; (5) Courses; (6) Outstanding credit;  
 (7) Commercial operations; (8) External; (9) Budgeted.

### COLLABORATION

Teaching activities act as an excellent catalyst of synergies and a resonance of efforts, the results of which generally appear rapidly.

Every day the number of collaborations maintained by the Institute of Energy Research increases in this respect.

Some of these develop into specific agreements for joint organization of a specific activity, but for the most part they are established and grow without this formal treatment.

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### **COLLABORATIONS**

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#### **National Organizations**

- Council of Nuclear Safety

Organization of IEE as a delegate body of the CSN for purposes of homologation, auditing and examination in the Training Courses for Personnel Operating Radioactive Facilities.

- Universities

Participation in Master's and Postgraduate programs.

Joint participation in research projects on radiologic protection.

- INEM

Joint organization of professional training courses financed by the European Social Fund

- Andalucian Technological Institute

Joint organization of courses on renewable energy sources.

- INAP

Joint organization of training courses for functionaries.

- Autonomous bodies

Participation in programs of personnel training.

- INSALUD

Organization of a program in training for protection from radiation for the INSALUD hospital staff.

- Secretary General of the Environment

Joint organization of a program of specialized training on themes of the environment and industrial safety.

- Nuclear electricity industry

Collaboration in IEE courses.

- Castillian Society of Industrial Medicine and Safety.

A training program for Radiological Protection for Specialists in Industrial Medicine.

### **International organizations**

- International Atomic Energy Agency

Acceptance of foreign grant recipients for training periods in Spain.

Joint organization of specialist courses on nuclear electricity.

- Ibero-American Cooperation Institute

Acceptance of students with grants.

- European Community Commission

Courses and seminars on industrial safety and radiological protection.

**ACTIVITIES FOR 1991**

During 1991 several lines of activity were maintained, quite like previous years.

- a) Courses for external students.
- b) Courses for professional training of CIEMAT personnel.
- c) Homologation, examination and certification of courses for the training of personnel operating radioactive facilities used in medicine and research.
- d) Scholarship courses for the training of research and technical personnel.

As is natural, the particular areas in which these activities have been developed have changed in parallel with the rest of the research and development projects in the other CIEMAT institutes.

**EXTERNAL COURSES**

The specialized and concrete character of much of the course work of the Institute of Energy Studies is a continual force toward emphasizing the Agency as one which offers specialized training services designed "to measure" in answer to the specific requirements of an industry or institute.

This type of course is superposed on the annual program of open courses which for some time the IEE has put out during the course of the year.

The experience accumulated during more than 25 years organizing courses on many diverse technologies related to energy and the environment, radiological protection and the management of technological risk, all permit the IEE to offer today a catalogue of courses appealing to very diverse technological interests.

All the themes of the courses given have some relation to the projects being worked on in CIEMAT. This gives the IEE the possibility to present in the courses results obtained in these projects, at the same time as having available well

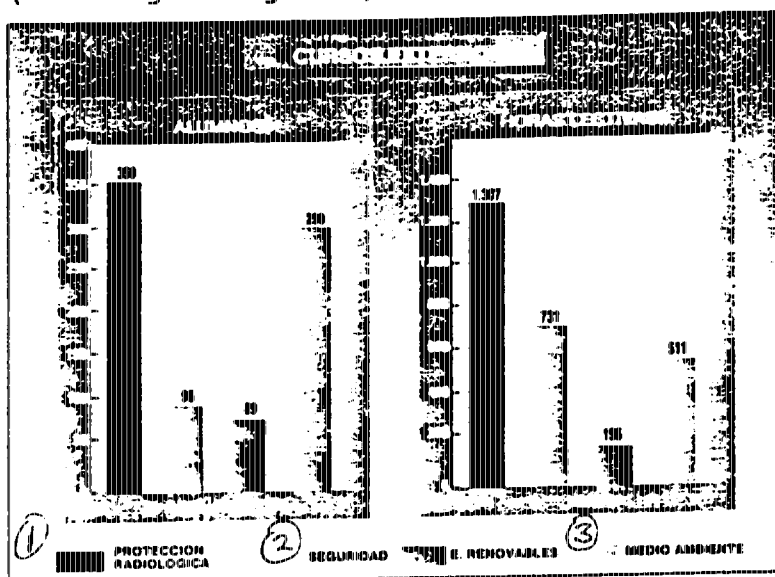
STUDENTS AND LECTURE HOURS IN EXTERNAL COURSES		
AREA	STUDENTS	HOURS
- Radiological protection	359	1,307
- Industrial and Nuclear Safety	96	731
- Renewable energy	89	155
- Environment	299	511
TOTAL	843	2,704

qualified experts who evaluate the courses both in the orientation and focus of their themes and in the selection of suitable instructors.

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The object of the courses is whenever possible to teach based on experimentation and research performed in our country, to put together different and complementary work groups, and, only if needed, with other foreign developments which serve to reflect or guide our position or theme, the effort called for or the road to follow.

(heading illegible, at bottom of box)



KEY: (1) Radiological protection; (2) Safety and Renewable Energy; (3) Environment.

This treatment is only achieved after a deep analysis of the programs and a careful selection of instructors, who are always practitioners of well-known research in their respective fields.

It is a good thing, and indeed one practiced, to in each case contrast different solutions, different alternatives, and to present both the solutions as well as problems in all their detail, from purely scientific ones to problems of economics or management which are in so many cases dependent on the development of technology.

#### AREA OF RADIOLOGICAL PROTECTION

The area of radiological protection is, perhaps, that in which the IEE has maintained the greatest increase in activity through the years. From its creation, the Institute has offered courses for the training of personnel operation of radioactive facilities and from the end of the '70's it has organized advanced courses in radiological protection. It has also taken every effort necessary to facilitate the creation of a training program for such personnel throughout the country.

Currently, the IEE maintains a program of activities in this area which is organized toward five levels of responsibility in the use of ionizing radiation.

At the first of these levels is the Advanced Course of Radiological Protection, lasting approximately 300 hours, and which is intended to provide the specialization necessary training of the Technical Units in Radiological Protection required in the current Protection Regulations for Ionizing Radiation.

An agreement with the Medical Faculty of the University of Complutense of Madrid permits the latter to award students who have passed the corresponding examination the title of Specialist in Radiological Protection for Medical Facilities.

The second level of responsibility is treated with the

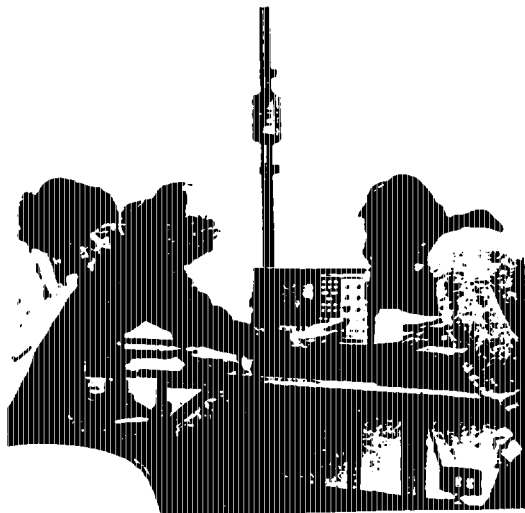
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Training Course for Supervisors of Radioactive Facilities which, through a program homologated by the CSN and passing several tests, entitles the students to become licensed as supervisors of radioactive facilities.

The same can be said on the Training Course for Operators of Radioactive Facilities which is organized with the same goal as the previous course and in the same fashion, but is aimed at the third level of responsibility in questions of safety and radiological protection: the operators of radioactive facilities.

For the other levels of responsibility, other personnel occupationally exposed, and others who, without exposure, work in radioactive facilities, the IEE offers specific seminars.

The effort which has been exerted for several years throughout the world to improve the safety of the use of ionizing radiation and the quality of all its applications has translated into a growing demand for concentrated courses of this type.



Identification of radionuclides using a multichannel analyzer.

During 1991 courses were organized and given for:  
The Castillian Industrial Health and Safety Society, The

Spanish Society for Radiological Protection, groups from the Guardia Civil and National Police, the nuclear power stations at Cofrentes and Sta. Maria de Garona.

Also the Training Program in Radiological Protection for Technical Personnel in INSALUD Hospitals and Outpatient clinics, which had developed in the past two years, was again put into practice in 1991 as a result of the agreement signed between that organization and CIEMAT. As the accord states, its goal is the training of personnel of hospitals and outpatient clinics who are occupationally exposed to radiation, as well as the training of personnel at facilities using radioactivity and radiodiagnosis in accord with the current legislation on the subject. To this end, seventeen courses were organized and distributed in many different INSALUD centers throughout Spain, in the islands as well as the Peninsula; 935 hours of lectures were presented and 493 students participated.

Another agreement signed in 1990 between CIEMAT and the San Carlos University Hospital and financed by INEM, supported the initiation in that year of activities orientated to training in radiological protection and quality control of radiodiagnosis, a cycle ending in 1991 with the practical classes in those courses which had not yet ended.

Very specific monographic lectures were also presented, dedicated to the continuing training of radiological protection specialists, and which present the most recent advances in a specific technique: examples are the courses in Industrial gammagraphy, Alpha spectrometry and Statistics for use in nuclear measurements.

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Another of the activities to mention is the organization of seminars on themes of special significance in the area of Radiological Protection, in collaboration with the Institute of the Environment and ENRESA, among which it is appropriate to single out, for its import and attendance, the seminar



presented on new radiological evidence and its relation to radiological protection and the establishment of dosage limits.

TRAINING IN RADIOLOGICAL PROTECTION IN CIEMAT FACILITIES		
Course	Students	Hours
- Advanced Radiological Protection	23	466
- Supervisors of Radioactive Facilities	30	207
- Operators of Radioactive Facilities	30	98
- Operators and Supervisors concerned with different units	120	425
- Special Single-subject courses	42	89
- Seminar cycle	114	22
TOTAL	359	1,307

#### AREA OF INDUSTRIAL AND NUCLEAR SAFETY

In 1990 for the first time the Master of Nuclear Energy course was held, a result of the very old Course in Nuclear Engineering. From January to December of 1991 the second Master's course was given, a teaching effort in the best tradition of the IEE. It was organized and presented jointly with CIEMAT and the Autonomous University of Madrid which conferred the corresponding academic degree. Its goal is to provide to postgraduates knowledge of the processes involved in the provision of nuclear energy placing special emphasis on the aspects of safety of operation and radiological protection. Collaborating, by conferring grants, were organizations and industries in the Spanish nuclear sector among which are worthy of mention CSN, UNESA, ENRESA, ENUSA, TECNATOM, EMPRESARIOS AGRUPADOS, ENDESA and INITEC.

In the first semester of the year the third edition of

the course on handling radioactive wastes was presented, which deals with the scientific, technological, safety and legal aspects of the handling of radioactive wastes. The course was promoted by ENRESA and was recognized as a doctorate by the Polytechnic University of Madrid. The joint organization of the course by these three institutions made this one of the most prestigious courses in the nuclear field.

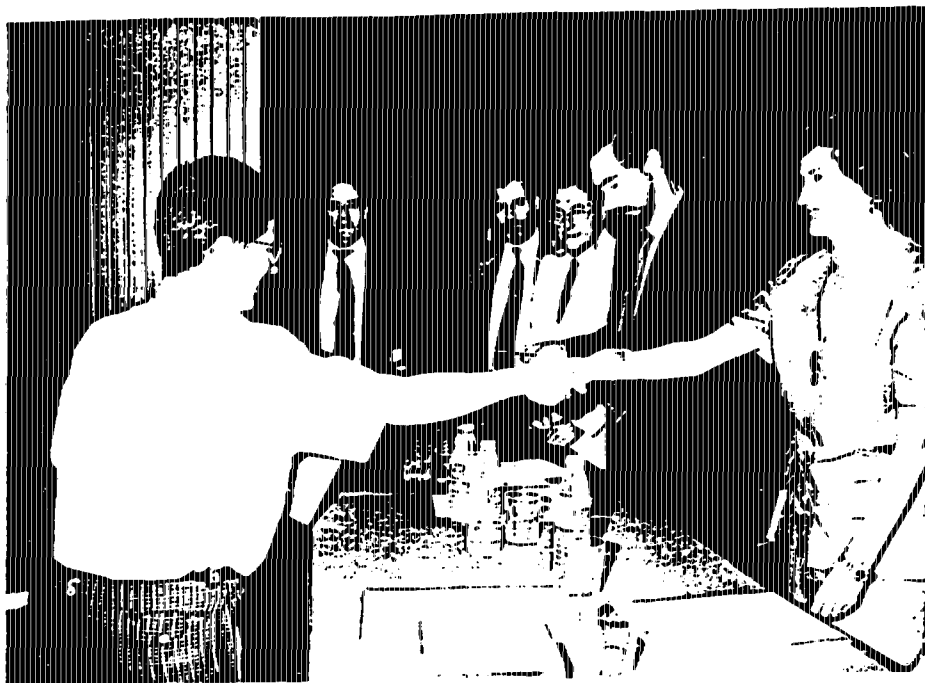
Even though nuclear technology has been the developing force behind the best knowledge for estimating and testing for hazards, these developments are being extended to other technological areas with important potential hazards. A parallel evolution has been followed in the training activities in these areas.

Thus in the month of June, a course on research in Safety and Risk Analysis in Industry was presented with the assistance of the European Community Commission and the Joint Research Center at Ispra. In this, the possible hazards most commonly found in technological processes were presented and their treatment discussed, dealing with technology in general and with the chemical industry in particular. The students were a group specially interested in these themes, now that their professional activity is increasing in the central and regional administrations and in businesses which have the potential of industrial hazards.

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As part of the Spanish support of the International Atomic Energy Agency, the Interregional Training Course on Quality Control in Operational Nuclear Power Stations was presented, lasting an entire month with a full work day schedule, from 15 October to mid November.

The IAEA funded the attendance of 16 foreign students coming from various Spanish American countries and from Eastern Europe. The course could be held thanks to the



Giving diplomas to students of the Radioactive Waste Management course.

exceptionally close cooperation of Spanish industry in the nuclear sector, especially engineering and services for nuclear power.

As a complementary activity, even though it is very important in this area, technical visits were made to the nuclear power plants in Trillo (Guadalajara), Valdecaballeros (Badajoz), Almaraz (Caceres) and Cofrentes (Valencia), to nuclear fuel production facilities at Juzbado (Salamanca) and uranium producers at Andujar (Jaen), and to installations for storing middle and low level radioactive wastes at El Cabril in Hornachuelos (Cordoba). It is absolutely necessary to thank all of these entities for the assistance which which they gave to perform this task.

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#### TRAINING IN INDUSTRIAL AND NUCLEAR SAFETY

COURSE	STUDENTS	HOURS
- Master of Nuclear Energy	17	476
- Handling Radioactive Wastes	32	45
- Studies in Safety and Risk Analysis in Industry	29	60
- Quality Control in Operating Nuclear Power Plants	18	150
<b>TOTAL</b>	<b>96</b>	<b>731</b>

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#### RENEWABLE ENERGY SOURCES

There is a general consensus on the role of renewable energy sources in future energy sufficiency, a role which the first relevant data are beginning to reveal. Currently its use is limited by high costs and it is the intention of all to take those actions needed to make it cost effective as soon as possible.

The work performed at the IER in CIEMAT is in this field, and perhaps the most important being carried out in Europe, is dealt with in a series of courses which, although short, is worthy of special mention.

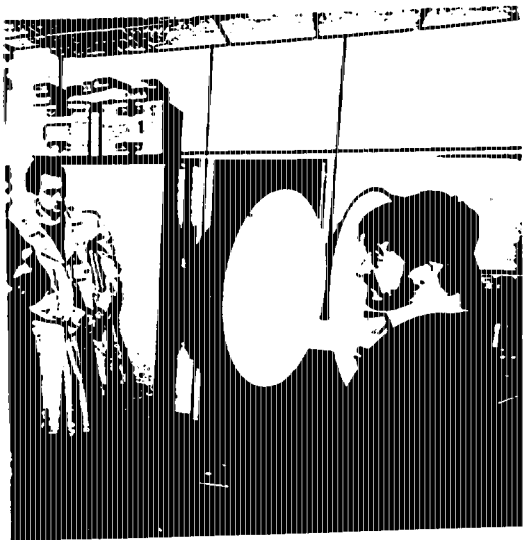
The first course of the year in renewal energy subjects took place at the Tabernas (Almeria) Solar Platform, and was directed to Foundations and Applications of Low and Medium Temperature Solar Thermal Energy. A short course, occupying two days, the most usual solar thermal technologies were studied, with attention on their operation, maintenance and use.

In the second half of September the course on Biomass as an Energy Source and Raw Material in Agriculture and Industry was presented for the third consecutive year. It has the cooperation of the IER, the Rural Fund of Soria Province and the Council on Economics of Castille and Leon which cofinanced the course. It was held in the School for Training and Agricultural Experimentation at Almazan and in the facilities of CEDER in Lobia (Soria). The theoretical classes were

complemented by visits to the facilities and businesses in the biomass exploitation sector .

In collaboration with the Andalucian Insititute of Technology, the course on Uses of Solar Thermal Energy in Building was organized, which also depended on the collaboration of the Economic Council of Andalucia. It took place at the Solar Platform in Almeria and its goal was to present the experience of professionals in the area of solar thermal energy and of architects in the application of passive and active solar thermal systems climate control.

In the second week of December the course on Basics, Specifications and Applications of Photovoltaic Solar Energy was held at Madrid. Its goal was to present the bases of the photovoltaic energy conversion, to show types and specifications of cells, costs, etc.



Practical visit to photovoltaic component laboratory.

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## TRAINING IN RENEWABLE ENERGY SOURCES

Course	Students	Hours
- Fundamentals and Applications Low and Medium Temperature Solar Thermal Energy	27	12
- Biomass as a Source of Energy and Raw Materials for Agriculture and Industry	21	78
- Applications of Solar Thermal Energy in Buildings	18	16
- Fundamentals, Specifications and Applications of Solar Photovoltaic Energy	23	49
<b>TOTAL</b>	<b>89</b>	<b>155</b>

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## THE ENVIRONMENT

The study of the environment constitutes the goal of a series of disciplines and techniques which in recent years have reached high degrees of development. CIEMAT, through its program of Environmental Technology, is an active participant in this task and this translates into organization by the IEE of courses with greatly varied content, for which, apart from the IMA technicians, it relies on the cooperation of other external organizations and on the financing of the State Secretary for the Environment and organizations like UNESA and ENRESA.

At the beginning of March the course on Measurement of Environmental Chemical Contamination was held in which the analytic techniques of gas, liquid and ionic chromatography were presented, together with mass and infrared spectrometry and NMR. From May to June the course on Sources of Pollution in Thermal Power Stations was held, with the goal of teaching those attending the techniques of measuring contaminants using the methods of differentiation, correlation spectrometry, and in a mobile lab. The last ten days of October were occupied by the course on Measurement of Background Radiation organized and presented jointly with CEDEX and MOPT. As a byproduct of this cooperation a course on Ambient Chemical Measurement was developed which presents the methods of statistical analysis

applied to the acquisition and interpretation of the results of measuring environmental contamination.

Another group of courses in this area consists of those which present aspects of management. The first, held in February, had the theme Environmental Energy Management in business with the goals of achieving a connection between alternative technologies for improving energy efficiency, alternatives to polluting energy sources, and the cost analysis of installing such technologies. In the middle of November a course on Solid Urban Waste Management was given which, a year earlier was prompted by a deluge of requests, coming particularly from the local and municipal administrative bodies and from businesses specializing in this area, with the course presenting the ideas involved in classification, recovery and recycling of solid urban wastes as well as the economic and legal aspects and the question of environmental impact.

For the third time also this year the course on Fluidized Bed Combustion was given, presenting the basic principles of this technology and the processes of fluidized bed combustion of coal, biomass and industrial wastes.

Two courses were developed which, although they are not strictly related to the environment, are mentioned here since they were organized in this area. One of them dealt with Gene transfer in higher organisms, on the techniques of introducing exogenous DNA into cells as a solution of fundamental problems in biology. The other was on Field Geology, which is a subject of an eminently practical nature, since theoretical classes were followed by spending the rest of the day in field work. The present version of the course was presented during the first two weeks in July in areas of Soria province. This course is cofinanced by the Government of Castille and Leon.

Finally it is necessary to mention a course on Energy in Livestock Wastes. This was the result of a direct contract placed with CIEMAT by INEM with the goal of enabling their

training staff to teach these techniques, acquiring both theoretical and practical knowledge for later use in training courses and development of teaching methods.

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Among technical visits made in this area can be mentioned the one made to the thermal power station at Velilla del Rio Carrion (Palencia), that to the dump at Valdemingomez (Madrid), and to the plant for treatment of livestock wastes at Almazan (Soria).

Apart from courses presented directly by the IEE and given in CIEMAT classrooms, CIEMAT also participated actively in other courses organized jointly with universities or other teaching bodies. Within the area of environmental studies, it is worth mentioning the Master in Evaluation and Correction of Environmental Impacts, organized by the Industry-University Foundation (Fundacion Universidad-Empresa) in collaboration with CIEMAT and various departments of the Complutense, Autonomous and Polytechnic Universities of Madrid.

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#### TRAINING IN THE ENVIRONMENT

Course	Students	Hours
- Measurement of Chemical Pollutants	32	71
- Thermal Power Station Emissions	31	17
- Thermal Power Station Inputs	21	40
- Environmental Chemistry Measurement	25	24
- Background Radiation	8	68
- Solid Urban Waste Management	36	30
- Managing Industrial Environmental Energy Use	31	27
- Fluidized Bed Combustion	19	21
- Field Geochemistry	20	100
- Gene Transfer in Higher Organisms	61	34
- Using the Energy in Livestock Wastes	15	79
<b>TOTAL</b>	<b>299</b>	<b>511</b>

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Additionally, and as part of the Course on Environmental Engineering organized by the Industrial Organization School



(Escuela de Organizacion Industrial) the section dealing with Risk Estimation and Evaluation was presented three times during 1991.

#### INTERNAL TRAINING

In spite of the efforts which are being made to facilitate the acquisition by employees of an advanced qualification in professional training, homologated by the Minister of Education and Science, the current reform of professional education has presented difficulties. An effort is continuing in this area and ways are being sought which will permit workers to acquire not only techniques but professional training which is the most competitive available.

Taking the professional path is one possible solution in the future, and in the hope that this will happen, steps have been taken in this direction.

During the present year there has been a change in position regarding the number of hours dedicated to the different themese in the area of internal training, with professional training coming to occupy the first position while the place of informatics passed to third, the opposite of what has happened in the past. This is in response to an effort being made to provide employees with easier access to adequate professional training and practice.

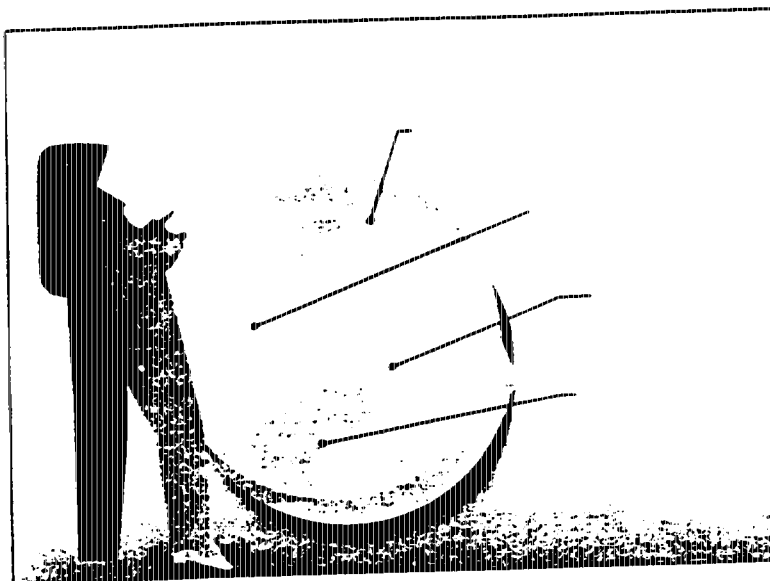
With the goal that the work force which has the basic knowledge represented by the academic degree FP1 but does not have the degree itself can acquire it, courses of exam preparation were given in seven specialties of this degree.

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For the first time a three-year program was put under way for training in the areas of Chemical Analysis, Metal and Electricity-Electronics, which consists in the presentation of Professional sections totalling 1,100 hours each, with content very similar to that included in the Level II Professional



Plan for professional training in chemistry.



sections planned in the Middle Level Education Reform. The program is part of the collaboration with INEM. In the final trimester of 1991 the trial use of the first section, in Chemical Analysis, was begun.

The instruction of languages still has second place. Learning English, which has increased recently, was overtaken this year by French in the basic and middle levels.

The number of lecture hours spent on learning informatics (basically the study of operating systems, editors and text processors) has not changed with respect to the previous year. For the first time courses for CEDER personnel were presented

in Soria.

A simultaneous series of classes was presented to CIEMAT employees who wanted to prepare for the examinations for Group C and Group D in order to take positions in the Agency as technical assistants and specialists.

The collaboration agreement with INAP was continued with the presentation of professional training courses for personnel in administrative jobs. As part of this program four courses were given to a total of 58 students. Those attending received from INAP the corresponding accreditation.

As in past years the program of training in radiological protection was presented through a series of seminars, special courses, video tapes, etc, for those CIEMAT personnel with occupational exposure. The first phase of this program was completed and in 1992 the phase of application and re-training of the entire staff working with radiation will begin.

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#### INTERNAL TRAINING

Courses	Students	Hours
- Instruction in FP-1 Regulations	33	915
- Languages	175	843
- Informatics	343	558
- Preparation for advancement	71	314
- Continuing training (INAP)	58	80
- Professional Occupational Training	10	46
- Training in Operation Management	13	24
- Training in Radiological Protection	208	65
<b>TOTAL</b>	<b>911</b>	<b>2,845</b>

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#### COLLABORATION WITH THE NUCLEAR SAFETY COUNCIL (CSN) FOR THE HOMOLOGATION OF TRAINING COURSES FOR PERSONNEL OPERATION OF RADIOACTIVE FACILITIES

Since its creation in 1980, the Nuclear Safety Council has maintained an agreement for cooperation with the IEE for the qualification of personnel who seek licensing as operators

or supervisors of radioactive facilities used for medicine or research.

The agreement involves not only the evaluation of institutions intending to give courses for the training of candidates for this license and its evaluation, homologation and final qualification, but also the preparation of concrete instructional goals in specific areas requiring a clearer definition of programs and standards.

During 1991 the evaluation, homologation, examination and final qualification of 48 of these courses was achieved, nine of which were organized by institutions without prior experience in this subject. A total of 1260 accreditation certificates were awarded.

Additionally the related teaching goals were defined and a practical exercise manual was developed for the preparation and practice in matters of radiological protection for personnel managing equipment incorporating neutron sources.

#### GRANTS FOR TRAINING RESEARCH PERSONNEL

The IEE offered its grants program in 1991 for the training of research personnel along the same lines as those taken by the National Program for Training Research Personnel, in the National Science and Technology Plan.

This program also includes the provision of grants for researchers from other countries who hold positions in CIEMAT laboratories.

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The experience of recent years and the changes in all countries has affected the relations between different components of the research community, and had suggested to CIEMAT the advisability of progressive substitution of this type of grant by practical training contracts which give the future research a better defined work situation and facilitate a growing participation in the responsibilities of the work.

1991 GRANT RECIPIENTS		
- From CIEMAT		46
-Environment	13	
-Fundamental Research	12	
-Renewable Energy	9	
-Technology	6	
-Nuclear Technology	3	
-General Technical Secretary	1	
-Operations Control	1	
-Administration and Finance	1	
- From Orther organizations		15
-OIEA	10	
-Ministry of Science and Education	4	
-EEC	1	
- Grant positions in the UCM		5
<b>TOTAL</b>		<b>66</b>

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TECHNICAL COOPERATION

## TECHNICAL COOPERATION

### INTERNATIONAL TECHNICAL COOPERATION

Activities in the field of international technical cooperation are summarized in the following sections.

#### Scientific meetings sponsored by International Agencies

All of the information concerning symposia, seminars, specialist meetings, training courses, vacancies, etc. which this Service receives from International Agencies is distributed, following selection, to the CIEMAT institutes and, in selected cases, to other national institutes that may be interested.

On receipt of replies, all the necessary documentation necessary for an application is forwarded to the interested party.

#### Grant recipients and Visiting Scientists

Requests are handled from grant recipients from International Agencies who are interested in improving their training in our country (research centers, hospitals, engineering units, consulting agencies, etc.). With a high frequency the training centers mentioned by the grantee in his request are not, for a variety of reasons, in a position to immediately satisfy the request. In this case it is necessary to find another center with similar characteristics which can accept the applicant. This task requires a great deal of time which is usually well compensated for by the results achieved.

Of the requests received it was possible to favorably respond to 11 OIEA grantees, with 40.5 man-months of time provided, most recipients coming from Iberoamerica. Seven of these grant recipients were funded by the OIEA, the other four by CIEMAT in conformity to the OIEA-CIEMAT (IEE) agreement. Their training was carried out in CIEMAT itself and other Spanish facilities.

A favorable response was given to the OIEA for 5 visiting scientists, all of them from Iberoamerica, who were able to get to know selected Spanish facilities in which they were particularly interested.

#### Commissions based on Bilateral Agreements

Within the framework of Bilateral Agreements for technical and scientific cooperation and based on the conclusions of the most recent Mixed Commission, research positions were granted to the following :

Poland: two scientists from the Central Laboratory of Radiological Protection, Warsaw, at the Institute of the Environment.

USSR: One scientist from the Moscow Academy of Sciences at the Institute of Renewable Energy.

During the course of this year there has been a proposal to increase the cooperation with the present CIS which contains the program established for a certian number of scientists and technicians from Russia and Ukraine [several words illeg.] to complete important research and development work for all of 1992 in the Institute of Basic Research. /168

Italy: Exchange of scientific visits as part of a joint research project.

Attendance of 8 researchers from different countries (Rumania, Hungary, Poland, Czechoslovakia, Russia) at the International Congress on Radionuclide Measurement (ICRM) which took place at CIEMAT.

#### OTHER AGREEMENTS

CIEMAT financing provided for:

P. R. China: two researchers at the Institute of Renewable Energy and one at the Institute of Fundamental Research.

Russia: Nine researchers from the Moscow Academy of



Sciences at the Institute of Fundamental Research.

Ukraine: Five scientists from the Institute of Physics and Technology at Kharkov, to the Institute of Fundamental Research.

Brazil: One researcher to the Institute of Renewable Energy.

CICYT financing for:

Czechoslovakia: One researcher to the Institute of Fundamental Research

P.R. China: One researcher to the Institute of Renewable Energy

#### PARTICIPATION IN GOVERNING BODIES OF INTERNATIONAL AGENCIES

The Steering Committee meeting of ESARDA (European Safeguards Research and Development Association) was attended at the session held at Avignon in May. During the meeting it was agreed to accept the CIEMAT offer to hold the 1992 Annual Meeting in our country.

#### PARTICIPATION IN MIXED COMMISSIONS FOR SCIENTIFIC AND TECHNICAL COOPERATION

CIEMAT was present at the following meetings held in 1991:

- 3<sup>rd</sup> reunion of the Mixed Hispano-Austrian Commission, Madrid, 11 and 12 Mar
- 6<sup>th</sup> reunion of the Mixed Hispano-Bulgar Commission, Madrid, 25 and 26 Feb.
- 1<sup>st</sup> reunion of the Hispano-Czech Mixed Commission, Prague 21 and 22 Feb.
- 1<sup>st</sup> reunion of the Hispano-Israeli Mixed Commission, Madrid, 25 June.
- 5<sup>th</sup> reunion of the Hispano-Italian Mixed Commission, Madrid, 21 and 22 Mar.
- 1<sup>st</sup> reunion of the Hispano-Rumanian Mixed Commission,

Madrid, 23 and 24 Jan.

- 4<sup>th</sup> reunion of the Hispano-Greek Mixed Commission, Madrid, 24 and 25 Oct.

- 6<sup>th</sup> reunion of the Hispano-Hungarian Mixed Commission, Madrid, 7 and 8 Nov.

#### CONVENTIONS, AGREEMENTS AND TECHNICAL SERVICES

In 1991, the Agreements Section of the Director of Operations Control was changed to the Office of Research Results Transferr (OTR), substituting for it in cooperation with the Institutes and Offices of the Agency in the transfer of the results of its research, thus channeling the management of Conventions and Agreements, Research Contracts, Technical Services etc, and carrying out follow up.

In the same year, OTRI-CIEMAT joined the OTRI/OTT network for which it receives a CICYT grant of 3.5 Mil Ptas annually. This network was created under the Law for Promotion and General Coordination of Science and Technology, or the "Science Law", and integrated into the General Secretary of the National Scientific and Technology Research and Development Plan with the purpose of bringing about the transfer of scientific and technological knowledge and achieving in this way a greater cooperation between the elements of the Science-Technology-Industry system.

The actions described are compatible with the science and technology policy of CIEMAT whose result has been that the majority of its projects are connected by collaboration with other agencies or industries on the national or international level, which results in:

- Assuring and increasing the quality of its programs
- Scientific and technological interchange with the community
- Access to external funding

This explains the diversity of the groups which enter into Conventions and Accords, as well as their varied goals.

## EVOLUTION AND CURRENT STATE

In the table below the agreements entered into and in force as of 31 Dec 1991 are grouped by year, showing their distribution by contracting units and by Institutes and Offices of CIEMAT, revealing the progressive expansion of the Agency to the outside, a fruit of the policy adopted. In the following tables the income due to Conventions and Agreements is detailed.

CONVENTIONS AND AGREEMENTS IN THE PERIOD 1985-91  
(31 Dec. 1991)

General Situation	ANT. 85	85	86	87	88	89	90	91	TOTAL
Signed	51	26	53	53	66	81	103	88	521
In force in 1991	21	10	21	16	31	51	91	79	320

Detail of Conventions and Accords in Force, 31 Dec 91  
by Contracting Entities

Public Administrations	8	5	5	5	10	28	36	39	136
Public Industries	4	1	3	4	7	4	7	2	32
Private Industries	6	4	4	1	6	9	11	10	51
European Community	—	—	2	1	6	3	19	17	48
Other International	3	—	2	4	1	2	14	10	36
Mixed*	—	—	5	1	1	5	4	1	17
<b>Total</b>	<b>21</b>	<b>10</b>	<b>21</b>	<b>16</b>	<b>31</b>	<b>81</b>	<b>81</b>	<b>70</b>	<b>320</b>

Detail of Conventions and Accords in Force, 31 Dec 91  
by CIEMAT Offices and Institutes

General	5	4	2	—	2	—	4	—	17
General Tech. Sec.	—	—	1	1	1	3	1	3	10
Personnel, Organization	—	—	—	1	—	—	—	—	1
Safety	—	1	—	—	—	1	—	—	2
Technology	3	2	—	3	7	8	13	6	42
Energy Research	—	—	—	—	—	1	3	1	5
Nuclear Technology	1	2	8	5	7	10	12	11	56
Environment	9	1	1	3	5	10	18	17	64
Fundamental Research	1	—	4	1	3	5	8	11	33
Renewable Energy	2	—	5	2	6	13	32	30	90
<b>Total</b>	<b>21</b>	<b>10</b>	<b>21</b>	<b>16</b>	<b>31</b>	<b>81</b>	<b>81</b>	<b>70</b>	<b>320</b>

\*Joint participation of CIEMAT and units of various groups

INCOME RESULTING FROM CONVENTIONS AND ACCORDS  
(Mil Ptas.)

Body	1988	1989	1990	1991
Public administrations	63	193	173	260
Public and Private Industry	351	374	494	882
International Organizations	200	444	723	782
	<b>614</b>	<b>1.011</b>	<b>1.390</b>	<b>1.924</b>

Income Resulting from Conventions  
and Accords, by Areas, 1991

Area	Income(MPt.)	%	Institute	No. Accords in Force	%
Gen. Tech Sec.	26	1			
Environment	355	18	Renewable Energy	90	28
Nuclear Technology	247	13	Nuclear Technology	56	18
Technology	523	27	Environment	64	20
Energy Research	33	2	Basic Research	33	10
Renewable Energy	286	15	Technology	42	13
Basic Research	438	23	Other	35	11
Personnel/Organiz.	16	1		320	100
	<u>1.024</u>	<u>100</u>			

Income Resulting from Conventions  
and Accords, by Subprograms, 1991

Subprogram	Income(MPt.)	%
Environment	355	18
Renewable Energy	286	15
Infrastructure/Training	157	8
Energy Research	112	6
Nuclear Fission Energy	598	31
Nuclear Fusion Energy	416	22
	<u>1.924</u>	<u>100</u>

Entity

No. Accords  
in Force %

Public Administrations	138	43
Public Industries	32	10
Private Industries	51	16
European Community	48	15
Mixed	38	11
	17	5
	<u>320</u>	<u>100</u>

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Participation in the National Plan for Scientific Research and Technological Development

CIEMAT participates in 10 of the 22 existing programs and in two additional sectoral programs out of 32 research projects.

The following table summarizes the present participation of CIEMAT in the National R+D Plan, with an indication of the programs it participates in.

SUMMARY OF PROJECTS CURRENT AND PENDING IN THE NATIONAL PLAN FOR SCIENTIFIC INVESTIGATION AND TECHNOLOGICAL DEVELOPMENT (1988-91) WHICH CIEMAT PARTICIPATES IN  
(AS OF 31 DEC 1991)

National or Sectoral Program	Number of Projects	Aid (Mpta.)			
		Sought		Granted	
		CIEMAT	others	CIEMAT	others
C. Forest Systems & Resources	1	8.5	—	8.0	—
E. Geological Resources	2	49.2	15.9	13.0	7.4
F. Marine & Aquaculture Resources	1	11.8	—	11.8	—
G. Conservation of National Patrimony and Processes of Environmental Degradation	3	81.1	10.9	23.8	—
H. Biotechnology	3	64.7	37.4	51.9	6.0
I. Adv. Automation/Robotics	2	29.9	14.8	23.5	10.0
M. Space Research	1	20.0	—	20.0	—
N. New Materials	3	52.2	9.4	22.3	8.4
P. Information & Communications Technology	2	14.6	56.5	13.2	46.3
Q. High Energy Physics	6	586.4	—	142.0	—
General Promotion of Knowledge*	7	103.6	33.5	84.2	9.9
Social Security Fund for Health Research*	1	8.8	—	6.0	—
<b>Total</b>	<b>32</b>	<b>1.030,8</b>	<b>178,4</b>	<b>419,7</b>	<b>88,0</b>

1) CIEMAT      2) Other      \* Sectoral Program

## CIEMAT PARTICIPATION IN EC PROGRAMS

The CE R+D programs are their main instrument of science policy. In this are included the most important areas of research, the funding available for each area, and the actuating power necessary for their development.

In the table below is a summary of the projects entered into by CIEMAT in collaboration with the EC.

The number of current contracts with the EC has grown from 1986 to 1991, reaching in December 1991 the figure of 43, equivalent to some 13% of the total of Agency collaboration with other entities.

SUMMARY OF CIEMAT/EC COLLABORATIVE PROJECTS AND  
THEIR ECONOMIC IMPORTANCE  
(CONTRACTS IN EFFECT 31 DEC. 1991)

Community Program Activity	CIEMAT Subprograms	Community Programs	Economic Data (MPTA) Total Size	Apportionment		
				EC	CIEMAT	Other
Energy	Nuclear Fission	6	965	295	417	253
	Nuclear Fusion	4	10,940	3,524	7,416	-
	Renewable	16	3,691	1,216	412	2,063
	Research	4	351	161	60	130
Quality of Life	Rad. Prot. & Environment	11	1,052	471	366	205
Community Sci-Tech. Cooperation	Renewable Energy	1	638	286 a]]	352	-
Operations	Rad. Prot. & Environment	1	757	109	75	573
Use of Biological Resources						
TOTAL		43	18,384	6,062	9,095	3,224

CURRENT CIEMAT PROJECTS IN THE NATIONAL RESEARCH PLAN OF THE  
COMMUNITY OF MADRID (1990-1993), AS OF 31 DECEMBER 1991

REGIONAL PROGRAMS	INSTITUTE OR OFFICE	PROJECT TITLE	PROJECT COST (MPTA)	Aid Requested (MPTA)	Aid Granted (MPTA)	Remarks
AGRICULTURE	Renewable Energy	Evaluation of solar PV systems	-	6.6	5.0	Infrastructure request
Environment	PRYMA	Regional cycling of atmospheric pollutants near Madrid	40.5	10.0	5.0	
	Renewable energy	Solar radiation sources in Madrid, measurement, spectral analysis. Photovoltaic system application	24.7	3.2	2.0	
	Renewable energy	Study of gases produced by urban wolid waste dumps. Atm. pollution & environmental degradation	20.0	5.6	2.6	
Use & elimination of urban & industrial waste	Renewable energy	Effect of solar energy on degradation of organic solvents. Development of waste stream treatment	72.6	11.0	7.8	
	Renewable energy	Production of high quality briquettes from agr. waste in Madrid. Tests of phyllo- toxicity and nitrogen fixing	-	7.0	5.2	Infrastructure request
	Renewable energy	Optimization of compost process of agr. waste in Madrid. Control of phytotox. of nitrogen	23.4	10.2	5.0	
	Renewable energy	Destruction of toxic wastes using high temp. solar energy	149.0	12.9	7.0	
	Nuclear technology	fluidized bed waste combustion	40.9	8.1	5.0	
TOTAL 3		7* 2**	371.1	61.0* 13.6**	34.4* 10.2**	

\* For projects

\*\* For infrastructure



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# TECHNICAL SERVICES

Independently of the activities reflecting Conventions and Agreements, CIEMAT is involved in other activities which, by their recurrent nature or their type, are not considered to be subject to the same sort of documented arrangements, as is the case with technical services, which can be defined as "work of a technical or scientific nature which is performed at the request of a third party, and for which is received in exchange a preestablished economic consideration."

In the table are summarized the technical services provided by OTRI since it took charge of their management and follow up, grouped according to whether their provision requires certification or not.

## TECHNICAL SERVICES PROVIDED

Services	1989	1990	1991
With certificate	63	119	148
Without certificate	95	64	54
Total	158	183	202

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
NUCLEAR TECHNOLOGY INSTITUTE		
ENUSA	Fabrication of prototype UO <sub>2</sub> fuel elements	16-01-79
UEF	Development of a prototype gamma thermometer	02-01-88
CSIC CSN UCM UPM UC ENSA CIAT TECNATOM OIEA	Research program coordinated by the OIEA for the optimization of the monitoring process for steel LWR vessels	19-02-86
OCDE CSN CIAT ENSA TECNATOM NUCLENOR	Management of Spanish participation in the OECD PISC-III program	06-05-86
TECNATOM	Monitoring of steel containment vessels in Spain	25-11-85
ENRESA	Solid radioactive waste storage facility installed in Sierra Albarrana	27-12-85
ENRESA	Provision of technical services in support of FUA (Andujar)	25-02-86
ENRESA	Final packaging of contaminated material and closing of FUA facilities	25-02-86
ENRESA	Packaging of radioactive wastes from medical, industrial and research use of isotopes. Contract for 3 years from 29-09-89.	02-10-86
ENSA TECNATOM UNESA	Project for research on steam generator tubes in PWR plants	29-07-88
WESTINTER	Fabrication of irradiation capsules	05-05-87
EPRI CSN ENUSA TECNATOM UNESA	Management of the Spanish participation in the EPRI LACE program. Supplements reff. 41/88 and 39/89 program of isotopes	24-03-87

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
EURATOM	Low level materials, MAT-18(resulting from the Fusion Association contract	30-05-86
ENRESA CEA ANDRA	Cooperation in the area of handling radioactive wastes, Addendum no. 1, 01-10-88	27-05-86
ENRESA CEA	Technical assistance in the area of handling radioactive wastes. Continued 2 years from 20-12-88	30-12-86
ENRESA	Research project on radioactive waste technology	01-10-87
BELGPROC	Packaging of MTR wastes. Clause added, 30 Oct 1989	22-12-87
ENRESA	Final treatment of radioactive wastes	30-06-88
CEA	Irradiation of steel samples (SACLAY contract)	15-12-87
ERCROS	Study on the separation of different rare earths.	01-07-88
ENRESA	Transport and storage of packages of medium and low radioactivity. Supp. I of Accord 48/87	30-06-88
CSN UNESA UPM TECNATOM	Development of Spanish participation in the ACE of EPRI. Severe accident chemistry.	23-12-88
CSN ENUSA TECNATOM UNESA UPM	Management of Spanish participation in the EPRI LACE program. Behavior of aerosols. Supp to 54/86	20-01-89
EURATOM	Identification and quantification of gamma emitters in packages of waste of low and medium activity. (FILW-0226-E-(EL))	12-10-88
UNESA	Experimental project on the intergranular corrosion of austentic stainless steels under load	18-12-89
ENRESA	Treatment of organic radioactive wastes coming from scintillation counters. Supp. IV of Accord 18/87. Complementary Accord signed 11-10-90	18-12-89

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
CSN ENUSA TECNATOM UNESA UPM	Development of Spanish participation in EPRI LACE program, management of internal and third party affairs. Regulation of associated jurisdictional relations (A 54/86)	12-06-89
CSN UNESA UPM TECNATOM	Management of Spanish participation in the EPRI ACE program, of internal and their party relations, and associated jurisdictional relations (A 34/88)	08-06-89
TECNOLOGIC	Development of a system to characterize electronic components in radioactive environments. Continued 21-02-90	15-07-89
UPV	Collaboration in development of advanced noise analysis methods	15-07-89
CEE JRC	Agreement for cooperation in materials and safety research	20-12-89
CSN UNESA ENUSA ENRESA	PHEBUS project. Internal and third party relations, Regulation of jurisdictional affairs. Supplement to Agreement 41/87	22-01-90
CICYT	Black lignite fluidized bed combustion	10-11-89
ENDESA	Project on "Behavior of reactor vessel materials under Neutron bombardment in LWRs"	14-11-89
EURATOM	Closure of reactor JEN-1(FI2D-CT90-0023)	13-11-90
EURATOM	Wet packaging of radioactive graphite from nuclear facilities (FI2D-0017-ES(JR))	27-09-90
ORGEMER	Commercialization of the process of continuous ion exchange in fluidized bed (CIX)	30-11-90
ENRESA	Probabilistic methods for analyzing the safety of radioactive storage sites. Supp. IV to Accord 13/7	01-03-90
ENRESA	Closure of Reactor JEN-1(phase 1). Plasma cutting technique. (Contract CE FI2D-CT90-0023) Supp. I to CIEMAT-ENRESA Association Agreement Ref 25/90	04-12-90
IW	Closure of JEN-1 reactor. Plasma cutting.	13-11-90
TRANSNUCLE	Transport of irradiated material	06-06-90

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CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

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Agency or Industry	Title	Date Signed
UA	Treatment and packaging of radioactive graphite from nuclear facilities	17-10-90
ENSA	R & D project for closure of JEN-1 reactor. Resulting from Contract (CE FI2D-CT90-0023)	15-01-91
LAINSA	R & D project for closure of JEN-1 reactor. Resulting from Contract (CE FI2D-CT90-0023)	15-01-91
CEE	Methodology based on hazard identification ability ('TOMHID')	17-09-91
IFE	Halden Reactor contractor, coordinated by OECD	02-10-90
EURATOM	Leaching of pure beta emitters and radionuclides with long half lives from real or simulated solidified wastes. no FI2W-CT90-0032 (DTEE)	18-04-91
CAM	Waste combustion in fluidized bed	04-12-90
CEE	Seminar on "Prevention of major industrial accidents"	17-12-90
OCDE	Halden Reactor project	01-01-91
UPM ETSIAG	Static and fatigue resistance tests of samples of Glass Fiber Resin Polyester materials with a specified lamination.	03-03-91
CEE	Study of safety and analysis of risk in industry	05-07-91
CSIC	Furnishing of a highly qualified CSIC person to CIEMAT	14-06-91
CICYT	Study of liquid-liquid rare earth separation	30-07-91
ENRESA	Research and technological development in the field of decontamination, treatment, packaging and characterization of wastes of low and medium activity. Supp. IV to the Association Convention of CIEMAT/ENRESA (Ref: 25/90)	20-12-91
UPV	Advanced studies in the area of man-machine interaction: computerized support systems for operation of complex facilities, and advanced control rooms	28-12-91

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
INSTITUTE OF BASIC RESEARCH		
DGII	Provision of metrological equipment	10-12-84
CSN	Program of reliability of dosimetry readings and interpretation of results	19-12-86
INITEC	Technological development of thermonuclear fusion	23-10-87
EURATOM	Effects of radiation on insulating materials (MAT 13, from Contract with Fusion Association)	30-05-86
SUI	Protocol on controlled thermonuclear fusion (resulting from Contract with Fusion Association)	30-05-86
UNESA	Protocol on controlled thermonuclear fusion (resulting from Contract with Fusion Association)	30-05-86
CEE BCMN	Alpha spectrometry (BCMN/ST/8890) Continued	23-10-1990 02-06-88
UCM	Excitation and ionization of atoms and molecules by laser radiation and electron spectrometry	26-12-88
EURATOM	Technology of structural materials (resulting from Fusion Association contract). Addendum 25-09-1990.	27-12-88
UEX	Measurement of low activity levels of uranium, radium and thorium in continental waters	30-03-89
ETHZ	Participation in general and infrastructure funding of experiment L3 at LEP accelerator	05-07-89
UPM	Design and analysis of interfaces and converters for long waveguides	09-01-89
CICYT	CAD for passive elements at micro-millemetric wavelengths	07-12-89
CICYT FISSS	Experimental methods for postal dosimetry and radiotherapy treatment. Application of Q.C. to radiotherapy	15-03-90
CICYT	Performance of experiments NA36, UA1 and L1 in the CERN SPS, SPPS and LEP accelerators	23-11-89
IFAC	Collaboration in the area of scientific research into the interaction of personnel, machinery and information	22-10-90
UIB	Measurement of low activities in alpha emitters in the environment of the Balearic Islands	22-05-90
HOSRACAJ	Measurement and dosimetry in radiodiagnosis	01-06-90

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CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

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Agency or Industry	Title	Date Signed
UCM	Real time laser analysis of melted steel	08-11-90
UV	Measurement of low activity in U, Ra and Th in water and earth of Valencia	17-10-90
UPV	Design of a liquid scintillation counter mounted with three phototubes	03-10-90
UCM	Construction and installation of a pumped dye laser using a flash lamp for laser fluorescence experiments	01-02-91
EURATOM	Fusion Association Contract (EUR 349-90-1 FUA E)	06-12-90
UCM	Studies of the equilibrium and stability of TJ-I-U and TJ-II	20-05-91
CICYT	Assistance in organizing a CERN physics school in Spain	10-06-91
UCM	Two dimensional models of plasma magnetohydrodynamic equilibrium	01-10-91
CICYT	Spectrometer for studying the form and fluctuations in spectral line intensity in fusion plasmas	02-08-91
CICYT	Experimental and technical study of turbulence phenomena in fusion plasmas	02-08-91
CAM	Congress of the International Committee for Radionuclides Metrology (ICRM)	25-09-91
CICYT	Study of natural radioactive pollutants (Ra, Th, U) in continental waters	05-08-91
CICYT	Participation in WA94	19-07-91
CICYT	Participation in RD5	19-07-91
CICYT	Plasma-wall interaction phenomena in thermonuclear fusion apparatus. Measurement of plasma boundary parameters using atomic activity and of sputtering phenomena using laser and mass spectrometry	26-09-91

INSTITUTE OF RENEWABLE ENERGY

AIE	Program on solar heating and cooling systems	20-12-76
AIE	Project for small solar systems. Modified in Sept. 1985 and Dec. 1987	06-10-77



**CONVENTIONS AND AGREEMENTS IN FORCE**  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
ASINEL UEF	Construction of 1 Mw wind generator	01-08-86
JCYL IDAE	Agreement for collaboration in energy	26-05-86
GC	Collaboration agreement	24-02-87
DGE	Collaboration agreement for renewable energy	30-05-86
ASINEL UEF MAN	Development, manufacture, testing and commercialization of a combined wind energy converter in the 0.8-1.2 Mw range	01-12-86
DLR	Cooperation in the field of thermosolar research, particularly in the long term use of the Almeria Solar Platform	15-10-86
CCL	Agreement on renewable energy	29-11-89
CCL	Monitoring and evaluation of energy savings in passive solar dwellings in Aguilar de Campoo and Torquemada (Palencia) Continued from 26-11-90	30-11-89
CCM	Monitoring and evaluation of techniques of using solar energy in dwellings in Alpera (Albacete)	01-12-87
CEE SEVILLANA ISOFOTON IES	Electrification of 57 rural dwellings using photovoltaic solar energy in the Sierra del Segura (SE 327-86)	03-02-88
CEE	Technical and economic evaluation of a process for producing alcohol from jerusalem artichoke tubers (EN38-0151-E(TF))	24-02-88
ASTAFERSA	General collaboration agreement. New applications of the technology of fabrication components from composite materials.	04-04-88
ASCAF	Agreement in the field of transforming lignito-cellulose materials	24-03-88
JA	Collaboration agreement	01-09-88
ABENGOA	Fabrication of a prototype cylindro-parabolic solar collector	01-05-89
JA	Evaluation and measurement of the solar passive behavior of Andalusian schools	22-10-90
CEE BP	Photovoltaic plant for electricity supply of waste water purifier (SE 121/87/ES)	25-01-89

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
SEVILLANA	Contract for sale of electricity generated by Tarifa experimental wind generator	10-11-88
PROCESA	Collaboration agreement for exploitation of renewable energy sources in Ceuta	27-02-89
PROCESA	Selection of sites for wind generators in Ceuta Modification of the 21-06-89 agreement	19-04-89
DGA	Collaboration agreement	20-09-89
UV	Study of dynamic and short term monitoring methods for passive solar buildings	21-11-89
HIDROLA	Agreement for development and research in solar photovoltaic systems	17-11-89
UPM	Collaboration in research on test cells to characterize passive components	30-11-90
AP CABAG	Project for a wind-diesel system for supplying electricity, water and other services in Punta Jandia (Fuerteventura)	19-12-89
CICYT	Preparation of polycrystalline semiconductor seeds. Application of electrochemical methods to characterization of amorphous and polycrystalline semiconductors	17-11-89
CICYT	Preparation and characterization of PIN semiconductor devices based on thin layers of amorphous silicon.	17-11-89
JA	Measurement of yield, operation and durability of and associated equipment for use in automated photovoltaic systems.	22-10-90
SEVILLANA	Agreement for collaboration in renewable energy	26-03-90
CEE	Reinforcement of current activity in using solar energy in industrial processes (GE1*-0019-ES(JR))	29-12-89
EMP	Development of simplified methods of simulation and energy analysis of passive solar buildings	04-12-90
CICYT	Optimization of amorphous silicon solar cells	07-05-90
CEE	OASIS: Optimization of amorphous silicon solar modules (JOUR-007-C(TT))	09-10-90
CEE BBRI	Spanish participation in phase II of PASSYS (Contract related to JOUE-00220C (GDF))	09-04-90

**CONVENTIONS AND AGREEMENTS IN FORCE**  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
SABSC	Monitoring and evaluation of schools in Guillena (Seville) and Almeria	26-03-90
UEF	Obtaining forest biomass in Galicia for use in a process of controlled pyrolysis	01-03-90
DELFT CF EINDHOVEN UTRECHT STUTTGART IMEC ULISBO	Cooperation agreement on optimization of amorphous silicon solar modules (from CE JOUR-0007-C)	09-10-90
UM	Collaboration agreement for development and research in solar energy	10-03-90
FORESCAL CICYT	Monitoring and technological improvements in coal fired boilers in neighbourhoods adapted for burning biomass pellets (CDTI priority project)	20-04-90
CEE ECN	Study of a reference procedure for establishing fatigue forces in large wind generators (associated contract)	14-02-91
CEE	Development of chemical cracking of lignocellulose biomass to obtain sugars, ethanol and other high value products at low costs (JOUB-CT90-0065) Supplementary agreement no 1, 13-02-91	12-11-90
CEE	Integrated handling of biogas produced in controlled waste dump sites. Artigas automated electricity generation (BM112-88 ES)	28-05-90
CSIC	Application of solar energy to treatment of metallic materials (Resulting from CE GE1*-0019-ES(JR))	01-04-90
JA	Thermal solar desalinization, phase II	22-10-90
JA	Study of the possibility for trials and test cell equipment for passive solar components. Characterization of a specific component	18-09-91
ICSTAM	Determination of the value of the density of direct solar energy as a heat source for the surface treatment of metals. Resulting from (CE GE1*-0019-ES(JR))	01-07-90
UMIST	Development and application of adaptive control and identification of strategies for fields of distributed collectors (from CE GE1*-0019-ES(JR))	01-07-90

**CONVENTIONS AND AGREEMENTS IN FORCE**  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
KUL	Application of concentrated solar energy to surface treatment of metals in deposition of ceramic layer. Structural study, from (CE GE1* 0019-ES(JR))	01-07-90
AICIA	Development of adaptive control of a solar desalinization plant (from CE GE1*-0019-ES (JR))	01-04-90
FGUPM	Development of computer program for non-stationary structural analysis of horizontal axis wind turbines	19-11-90
UB PROCITEC	Study of technical viability of a photocatalytic purification process using concentrated solar rays (from GE 1*-0019-ES(JR))	19-09-90
UTOR	Experimental study of photocatalytic processes for detoxification of liquid effluents (from GE1*-0019-ES (JR)) 0019-ES (JR))	21-07-91
TRICO	Preparation and analysis of samples of metallic materials in preparation for PSA trials (from GE1*-0019-ES(JR))	18-07-90
CEE ARMINES	Operation of a solar-diesel-electric milking parlour in Pozoblanco (Cordoba) phase II (JOUR-CT90-0116)	22-02-91
CEE SAICA	Collaboration in the field of biological processes of paper mill effluent treatment (from AGRE-CT90-0044(SMA))	10-04-91
CEE UPM	Collaboration in the field of using sorghum bagasse (Contract JOUB-0036-C(CD))	19-04-91
CEE	Measurement and modelling of wind in complex terrains (JOUR-0067-C (MB))	18-12-90
DGA GESTENGA SINAE	Evaluation of market potential of wind generators in Galicia and the Ebro valley	03-12-90
DGA GESTENGA SINAE LNETI	Measurement and modelling of wind in complex terrains. Use in areas of high wind energy in the Iberian Peninsula: Galicia, Ebro Valley and Southern Portugal	03-12-90
ZELLPLAN	Development of chemical cracking of lignocellulosiematerials to obtain sugars and ethanol fuel (from JOUB-CT90-0065)	29-11-91

**CONVENTIONS AND AGREEMENTS IN FORCE**  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
CAM	Optimization of the process of composting agricultural wastes in Madrid province. Control of phytotoxicity and nitrogen fixing	04-12-90
CAM	Effect of solar energy on degradation of organic solvents. Development of its use for treatment of a waste stream	04-12-90
BERTIN	Cooperative agreement (from CE JOUB-CT90-0065)	28-01-91
CAM	Evaluation of pumping units powered by photovoltaic electricity	10-09-90
CAM	Fabrication of high quality briquettes from waste phytomass for energy purposes	10-09-90
REGIS	Agreement (from AGRE-CT90-0044-SMA)	19-04-91
CEE VINSA EHN	Innovation in promoting housing with passive solar systems, in Mendillorri (Navarra) Phase I	05-09-91
UPM	Analysis and energy evaluation of buildings in bioclimatic projects	25-02-91
AICIA	Simplified models for designing and modelling for determining building energy behavior	09-04-91
EEIG	Creation of the European agency for power stations using renewable energy	15-05-91
CEBAS	Composting of sorghum (subcontract from CE JOUR-0036-C)	02-07-91
CEE CONPHOEBUS	Calibration of solar sensors (subcontract from CE JOUR-0098-I(A))	14-06-91
SYPER	Preparation of high resolution solar radiation maps in Andalucia based on Meteosat satellite images	15-07-91
JA	Preparation of high resolution solar radiation maps in Andalucia based on Meteosat satellite images	15-07-91
CICYT	Design of biopurification of paper mill effluents	13-06-91
AICIA	Evaluation and measurement of the techniques of climate control in open areas of EXPO '92	15-07-91

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
JA	Evaluation and measurement of climate control in closed areas of EXPO '92	15-07-91
SERMASA	Study of the viability of using biogas energy produced in the controlled waste dump at Colmenar Viejo, belonging to Madrid	15-07-91
CAM	Study on the gasses generated in urban solid waste dumps: atmospheric contamination and environmental degradation produced by them.	19-07-91
CAM	Solar energy resources in the Community of Madrid. Measurement and spectral analysis. Application to photovoltaic systems.	10-07-91
	COS	
CAM	Destruction of toxic and dangerous wastes using concentrated high temperature solar energy	10-07-91
URF CEE	Photovoltaic power station, 1Mw, in Spain. Production contract (subcontract CE JOUR*-008-C(JR))	01-10-91
CEE BESEL VINSAL	Design of innovative active and passive solar systems, based on the concept of a ventilated atrium for three apartment blocks (48 floors), Mendillorri,2)	17-12-91
JA	Evaluation of agricultural pumping equipment powered by photovoltaics	18-09-90
ISFH	Intensification and new developments in industrial processes using solar energy	15-11-91
CEE	VI International Conference on technologies of concentrating solar heat	21-10-91
FDE	Design, construction and trial of a 2.5 MW volumetric air receiver.	19-12-91
JCYL UVA CEE	Evaluation of the potential of biomass and its development in Leon and Castille	23-12-91

ENVIRONMENTAL INSTITUTE

DOEUSA	Collaboration in Health and Safety	25-02-66
CSN	Program of quality control for PVRMA. Samples and environmental measurement of radioactive gases. Dosimetric services	04-04-84
ENUSA	Analysis for PVRMA of Saelices el Chico (Salamanca)	23-05-84

**CONVENTIONS AND AGREEMENTS IN FORCE**  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
ENUSA	Analysis for PVRMA of mine operation at La Haba (Badajoz)	23-05-84
UEF	Quality control for PVRMA at Jose Cabrera Nuclear Station (NS)	30-07-85
CNAL	Quality control for PVRMA at Almaraz NS	18-05-84
INYPISA	Quality control for PVRMA of Asco I and Vandellos I NS	22-05-84
GEOCISA	Quality control for PVRMA at Cofrentes NS	11-06-84
CNTR	Quality control for PVRMA at Trillo I NS	02-07-84
CNVL	Quality control for PVRMA at Valdecabelleros NS	03-09-84
GEOCISA	Radiological analysis in the laboratory for JEN emergencies	05-05-86
IEO	Collaboration agreement	16-02-88
ENRESA	Technical services for tests of radon barriers	26-06-87
AM	Radiological environment monitoring of Villa de Madrid	01-06-87
ENRESA	Radiological impact of storing radioactive wastes	15-06-87
CEE	Mesometeorological air pollution cycles in the Iberian Peninsula (EV4V-0097-E-(A))	26-01-88
CAM	Collaboration agreement	28-12-88
ENRESA	Characterization of atmospheric processes in complex terrain Supp III to Accord 15/87	15-02-88
UAM	Gene transfer as a method of prevention and treatment of animal viral infections. Accord with CICYT Ref 79/89	01-03-89
CICYT	The cytokeratine gene family: structure, function and regulation of differential expression (Amplification of 1989 Science Program)	28-07-88
UCM	Mesometeorological pollution cycles in the Iberian Peninsula	29-06-89
ISCH	Mesometeorological pollution cycles in the Iberian Peninsula	29-06-89
UPV	Mesometeorological pollution cycles in the Iberian Peninsula	29-06-89

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
ISCIII	Cooperative agreement for the development of activities in the subject of atmospheric pollution	28-06-89
CICYT	Behavior of trace elements in mediterranean marine ecosystem	15-11-89
CICYT ANDROMACO	Study and development of polysacchrides as active agents in hematopoiesis (CDTI priority project)	03-07-89
ISCIII MIGJORN	Effects of atmospheric pollution on Ebro delta	31-12-89
ENRESA	Radiological and environmental protection, characterization and modelling of the biosphere. Supp IV to agreement 15/87. Partial continuation of the accord of 14-06-91	30-12-89
CICYT	Gene transfer as a method of prevention and treatment of animal viral infections. Agreement with the UAM ref 55/88	16-05-89
EURATOM	Radioecology of the transuranides and other long lived radionuclides (B17-0042-C(EDB))	04-10-90
EURATOM	Disfunction and neoplasias of the hematopoietic and bone structure following external irradiation or radionuclide contamination of bone, en utero or neonatal development	04-09-90
EURATOM	Measurement of environmental gamma levels (B17*-0027-C(MB))	31-05-90
EURATOM	Transfer of radionuclides accidentally released in agricultural environments (TARRASO B17-0046-C(JR))	12-09-90
CEE	Regional cycles of air pollution in the central-western zone of Mediterranean (STEP-0006-C(JR))	05-04-90
CCI CEE	Collaborative agreement for enviromental research	26-11-90
UPM	Development of optoelectronic sensors for the measurement of industrial chimney gases	10-12-90
UAP	Cooperative agreement in atmospheric pollution	15-10-90
CICYT	Mesometeorologic atmospheric pollution cycles in the Iberian Peninsula	17-05-90
AC	Collaboration for the interchange of information and evaluation	31-05-90
AM	Environmental radiological monitoring in Madrid	15-11-91



**CONVENTIONS AND AGREEMENTS IN FORCE**  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
MRC	Dysfunction and neoplasia in hematopoietic and bone tissue as a result of external irradiation or radionuclide contamination of bone en utero or in neonatal development. From (CE B17-0001-C)	10-10-90
NRPB	Collaborative agreement on radiological protection	22-02-91
GEOCISA	Analysis of samples for the environmental radiological monitoring program at Vandellos II NS	30-03-90
CSN	Radon measurements inside Madrid and Barcelona houses	16-10-90
CSN	Transfer of radionuclides, dumped by accident in agricultural biosystems	16-10-90
CEE	Priority Action Conference, Processes of Atmospheric Oxidation (COST 611)	15-11-90
CEE	Interaction of polluted air, climactic and nutritional factors on conifer physiology	10-07-91
OIEA	Effects of soil characteristics and agrarian practices on the chemical form of plutonium and americium in polluted agricultural areas	01-11-90
CAM	Regional atmospheric pollution cycles in the Madrid basin	04-12-90
UB FBG	Transfer of radionuclides accidentally dumped in agricultural systems and the development of actions to reduce food contamination	02-01-91
FRA	Inactivation of genes in mammals. Generation of rat families with cytoskeletal alterations using homologous gene recombination of cytokeratins in ES cells.	05-12-90
ANAI	Analysis of samples for quality control in the program of environmental radiological monitoring at the Asco NS	02-01-91
UAB	Measurement of radon levels inside buildings	02-01-91
CEE	Use of Cosyma software package	09-01-91
UB FBG	Migration of radionuclides in Mediterranean ecosystems	02-01-91
UAM	Study of environmental degradation due to dumping solid urban wastes in the five disposal sites of the Comunidad de Madrid	25-05-91

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
CICYT	Regional pollution cycles in the central-west Mediterranean	24-06-91
CEE	Integrated European plan for the lysimetry experiment in the RESSAC project (SC-008-E/BI6-0122-F)	24-07-91
HIFRENSA	Analysis of samples for quality control of the environmental radiological monitoring of Vandellos I NS	03-01-91
FBG UB	Characterization, extraction and transport of a solid piece of typical mediterranean soil for the EC EURO-RESSAC program	03-06-91
AECB AECL SSI ENRESA	Participation in validation study of the biosphere model (BIOMOWS-2)	01-10-91
CICYT	Regulation and differential function expression of cytokeratines. Use of the regulatory elements of their genes for direction of ectopic expression of other epithelial genes	30-09-91
AIE	Participation in the executive committee for co-operation of the AIE in R+D relating to carbonic anhydride and other dump gases	20-11-91
CSN	Campaign of analytic comparison of radioactive measurements	26-12-91
TECHNOLOGY DIRECTORATE		
EISA	Technical-industrial cooperation	23-11-79
CSN	Support of the JEN calculation center and use of its resources	19-12-85
DIC	Collaboration agreement	13-12-84
DIC	Technical management of fabrication of equipment for radiological protection	13-12-84
ARIES	Transfer of technology for fabrication and commercialization of the portable monitor for measuring gamma and beta radiation, Mod. MRN-8-P and probe SBN-8P	16-07-85
DGAM	Research and development of equipment for detecting ionizing radiation	12-11-87
ESSA	Automatic data recognition equipment for measuring environmental contamination	05-06-87

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
CSN	Installation of a computer in the Calculation Center and joint use of computing resources	18-12-87
UCM	Study of the nephrotoxicity of amino-glucoside antibiotics and its prevention	01-07-88
ENRESA	Study of radionuclide migration	26-02-88
ENRESA	Mobility of radionucleides in a granitic medium under the influence of complexes and colloids. Supp. I to Accord 46/87 Budget supplement : 11,147,425 PTA	14-03-88
ENRESA	Characterization of milled mixtures of clay/granite for construction of radionucleid barriers. Supp. II of agreement 46/87	14-03-88
UAM	Growth of mercuric iodide monocrystals in volume for use in radiation sensors. Extension dated 18-10-91	01-03-89
UB UAB UPC ESADE IEC UAM UPM UCM	Integration of the CIEMAT EARN node into the national IRIS academic network (signed also by FUNDESCO, UAM-IBM science center, UCO, UL, UO)	01-01-88
NEW JERSEY	Environmental study of complexes and colloids in water in granitic soils. Complementary accord signed 01-07-91	07-06-88
ENRESA	Characterization of filling and sealing materials for storage of wastes. Supp III to 46/87	10-04-89
UCM	Metallic ions and biliary acids in processes of heavy metal poisoning	01-12-88
RHONEPOULE	Pharmacokinetic and metabolic study of spiramycin and acetylspiramycin	07-06-89
RHONEPOULE	Collaboration agreement	07-06-90
CICYT	High energy calculation network Extension of 07-11-90	23-06-89
UPM	Development of neural network models for application in recognition and identification of radiation spectra and automated sensor control	01-06-89
CSIC	Research and development in robotics	08-09-89

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
CICYT	Development of an algorithm for generation of images of radioactive sources	06-11-89
ENRESA	Hydrogeochemical study of the 'Los Morales' peak (El Cabril). Phase I. Sampling and in situ analysis	16-04-90
EURATOM	Development of an intelligent vision system for radiation (FI2T-CT90-0007)	22-11-90
CICYT	Satellite communication using OLYMPUS for data transmission at 8Mbps	26-11-90
RHONEPOULE	Interchange of technical information	30-01-90
AMYS	Development of a radiation vision system	03-05-90
CUJ	Pharmacokinetic and metabolic study using radioactive tracers and experimental animals of new therapeutic molecules for image diagnosis. Added 01-05-91	01-03-90
UAB	Development of the procedure for preparing a kit of radioimmunoanalysis for determining methalotioneins	02-07-90
EURATOM	Radiation-tolerant camera 'TELEMAN-34' (FI2T-0010-C(CD))	14-12-90
EURATOM	Characterization and validation of migration processes of natural radionuclides under real conditions in a fissured granitic medium (El Berrocal)	04-09-91
ENRESA	Study of ultimate source of interstitial water in the FUA dump. Supp II to the Association Agreement CIEMAT-ENRESA ref 25/90	04-12-90
ENRESA	Analysis and hydrogeochemical interpretation of the peak of Los Morales (El Cabril). Supp III to CIEMAT-ENRESA Association Agreement ref 25/90	04-12-90
CICYT	Control system for a walking robot	27-11-90
CICYT	Development of intelligent electromagnetic radiation sensors in a narrow band. Use of neural networks for adaptive control of the transducer instrumentation chain. Hybridization of the sensor analog display	12-12-90
CEE	Third conference in chemistry and migration of actinides and fission products in the geosphere	20-12-90

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**CONVENTIONS AND AGREEMENTS IN FORCE**  
(22 Jan 1992)

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Agency or Industry	Title	Date Signed
ENRESA	Investigation and technological development in the field of radionuclide migration and the behavior of natural and artificial barriers to migration. Supp V to the ENRESA-CIEMAT cooperation agreement ref 25/90	01-04-91
FUNDESCO	Management and operation of access to the Cray supercomputer	01-01-91
UPM	Mutual provision of information services	02-01-91
CICYT	Funding of the traffic generated by users of the physics and high energy network (FAENET) in the years 1988-1991	23-05-91
FUNDESCO	Management of Iris Net services based on DECNET architecture	25-10-91

**GENERAL DIRECTOR**

CENER	Cooperation agreement	28-10-82
UPM	Scientific cooperation agreement	11-01-83
CSN	Cooperation agreement	04-04-84
ENUSA	Cooperation agreement	16-04-84
UCM	Cooperation agreement	06-05-85
UNED	Cooperation agreement in science	11-10-84
UAM	Cooperation agreement	08-10-85
CEDEX	Cooperation agreement	23-01-85
TECNATOM	Cooperation agreement	25-11-85
UAB	Cooperation agreement	30-06-88
PRESUR	Cooperation agreement	25-06-86
DOEUSA	Understanding for cooperation in research and development in the area of energy	06-06-86
UB	Cooperation agreement	02-02-88
EMP	Cooperation agreement	03-12-90
DGPC	Cooperation agreement for technical assistance in the area of chemical hazards	26-06-90

CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

Agency or Industry	Title	Date Signed
ENRESA	CIEMAT-ENRESA association agreement	20-07-90
INSHT UCM	Work place analysis	08-06-90

GENERAL TECHNICAL SECRETARY

INFE	Contract for access to INFE data base	19-05-86
ENRESA	Provision of technical services	14-01-88
AIE	Establishment of a system of data interchange in energy technology	26-01-87
CSIC	Collaboration agreement	09-06-89
CSCAE	Collaboration agreement	15-12-89
UKAEA	Contract for transport and packing of fuel rods	12-12-89
ENRESA	Removal of Zorita fuel rods	30-01-90
BELGPROC	Service related to preparation for packaged waste exchange in project SWAP, wastes belonging to CIEMAT and now stored at BELGOPROCESS	08-05-91
RSEF	Collaboration agreement	14-06-91
UAM	Increase and reevaluation of the epidemiological study of the possible effects of exposure to low doses of radiation on the health of CIEMAT employees	30-10-91

INSTITUTE OF ENERGY STUDIES

UEX	Collaboration agreement	10-03-89
USAL	Collaboration agreement	16-03-90
UIB	Collaboration agreement	21-05-90
CAM	Contracts for practical works	03-12-90
UAM	Master's course in nuclear energy	08-10-91

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CONVENTIONS AND AGREEMENTS IN FORCE  
(22 Jan 1992)

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Agency or Industry	Title	Date Signed
HEALTH DIRECTOR		
CSN	Access, use and exchange of documents and bibliographies	19-12-85
DGPC	Provision of a fire engine	10-11-89
DIRECTOR OF PERSONNEL AND ORGANIZATION		
EURATOM	Health effects on the JEN personnel of low doses of radiation (BI6*-0229-E(A)). Additional contract on 18-02-89	23-06-87

**COMMUNICATIONS**



## COMMUNICATIONS

### PUBLIC RELATIONS AND IMAGE

In 1989 a communications plan was established with the goal of increasing public awareness of CIEMAT as an R & D agency, and the center, which is active within the two large sectors of the Basic Community Research Program in Quality of Life and Energy Production, strengthened its relations with the communications media in the following ways:

- News releases explaining scientific advances, by the researchers themselves, using a variety of communications media (scientific reviews, news magazines, daily press, radio and television coverage, etc.)
- Regular transmission of communiques to the press and organization of news conferences, where the up to the moment details of technological or research projects were assembled.
- Provision of incentives for news coverage of programs of great breadth or of large installations.
- Continuing response to the growing demand for science reporting in the media, due as much to the growing interest science subjects awaken in the reader as to the increase in the number of existing news media.

In spite of the attention the Center has given to media requests, it has not passed on information when the request has been made for information concerning:

- Functions assigned to the Ministerial Departments in general, and to the Industry Minister in particular, as well as its regional development policies.
- Aspects of regulation or normalization in any area of the administration whatever.
- Legal position of Agencies or Public Enterprises.

Work in the area of Communications and Videos has been sustained by the establishment of permanent contacts with the mass communications media as well as in numerous Center

activities produced for the benefit of the main public, such as conventions, science days or seminars, which make available the necessary information or facilitate imparting it to the press.

The results of these activities can be measured as a function of the nearly 300 articles dedicated to the different scientific achievements of CIEMAT, and in the number of press, radio and television professionals and agencies which have established relations with the Center.

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Press roundtable.

The work of news presentation, which covers all the research themes CIEMAT is involved in, has been facilitated by the collaboration of a large part of the Agency personnel, from the Director, who has signed a total of 10 articles, to experts and scientists who have completed about 20 written reports. Additionally, different specialists have granted a total of 110 interviews.

Within the Area of Communications and Image there is a

data base with information on the communications media in Spain. Additionally, there are available fact sheets and information on the work of the Agency. All the activities of this Area are systematically evaluated in acord with the very real presence of the Center in the media.

Another important aspect of the work was the consolidation of the logos (corporate image), which appear on publications and publicity sheets. In 1991 16 publicity sheets were placed in selected media, with the aim of connecting the research and development activities of the Center with the sectors related to the corresponding scientific advances. The announcements of courses and books prepared by CIEMAT, and public offers of employment, have also increased, raising the number to nearly 130 announcements made public in this way.

#### INFORMATION INFRASTRUCTURE

The Area of information infrastructure must support the different Institutes and Offices of CIEMAT in the fields of Information Services, Publication, Publicity Support and Audiovisual Media.

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Reprographics.

As far as the results obtained for later publication, the daily "Information Services" bulletin should be mentioned, which follows the notices and information appearing in the Official Bulletins of The European Communities, Congress and Senate, Official Bulletins of the Autonomous Bodies, scientific and technical reviews and the national daily press, as well as a daily summary of the international press. Additionally, various forms of releases are published (brochures, posters, bulletins, memos, technical sheets, etc). Various videos of activities and projects at CIEMAT have been produced which in addition to presenting information about Agency activities, make it available for telediffusion. Also, the Agency has participated by giving technical support to selected research projects. A transparencies database is also being set up.

All of this has provided support to the Agency in its relations with different communications media, industries and scientific communities in the different areas of research and development carried out at CIEMAT.

#### PUBLISHING ACTIVITIES

The publishing activity of CIEMAT in 1991 was performed in accord with two main goals, the reduction of costs and the optimal use of resources, both human and material.

Cost reduction was made possible thanks to an increasing use of the production facilities, with much of the work being carried out in Center facilities.

The professionalism of the technicians and operators managing the information resources, together with the use of modern technologies, has resulted not only in increased production, but also in an improved production quality.

In agreement with the diversification of the activities of the Agency, new publishing lines have been started and those already existing have been strengthened. Furthermore, the process of preparing the various periodic bulletins of the

Center has been perfected, as well as the production of brochures and posters, and the policy of providing graphics for various CIEMAT activities has continued.

The fruit of this labor has been the increase in the Publications List which, conceptually, consists of the following subjects:

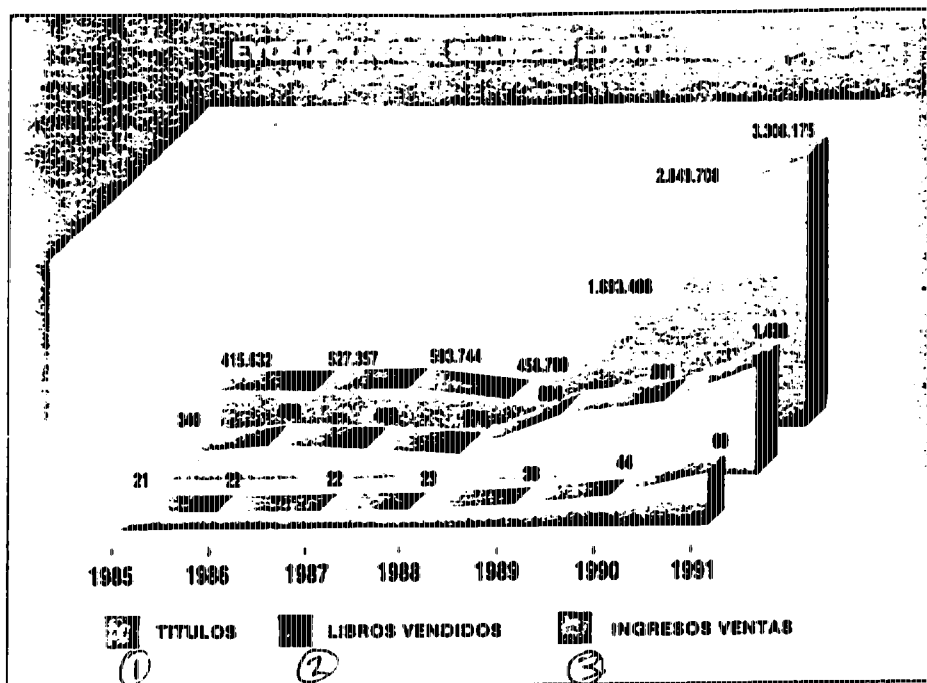
- Results of research performed by our Organization
- Highly specialized texts relating to some of the subjects essential to CIEMAT. thus assisting in the diffusion of this knowledge in the hispanophonic world.
- Course notes for postgraduates and professionals, supplied by the Institute of Energy Studies at CIEMAT.
- Proceedings, conferences and other relations of a scientific character, resulting from meetings and seminars organized by or with the participation of the Center.
- Other types of knowledge related to specific activities of CIEMAT, which do not constitute a bibliographic unit and which fall outside of other series of publications.
- Printed matter for publicity purposes, related with the identity or activities of the Center.
- Internal manuals and documents which are used in the organization of CIEMAT.

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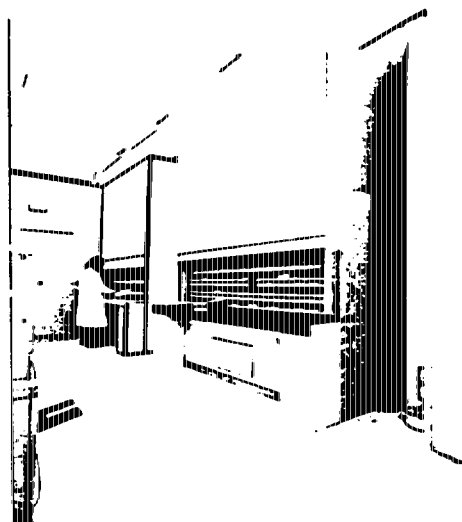
#### CIEMAT PUBLICATIONS SUMMARY OF PRODUCTION IN 1991

- CIEMAT Information Series	14
- Communications Series	13
- CIEMAT Documents Series	1
- CIEMAT in Communications Media (Pb.)	6
- CIEMAT in Communications Media (Hb.)	6
- CIEMAT Annual Report 1990	1
- English and Spanish Memos IIB	2
- Advice Manual 1991	1
- Following and evaluation of technical and scientific activities at CIEMAT, 1991	1
- CIEMAT Publications List	1
- Open Courses List IEE, 1991	1
- Ed. 2, Open Course List	1
- Publications for Young People, 1990-1	3

- CIEMAT Information Leaflets	5
- Manual of CIEMAT Medical Service	1
- CIEMAT Medical Service Documents	1
- Activities of CIEMAT in Environmental Technology	1
- Other	10
<b>Total</b>	<b>69</b>



Growth of CIEMAT Publications Service  
Key: (1) Titles; (2) Books Sold; (3) Sales Income.



Microfilm Archive.

#### DOCUMENTATION

During 1991, the Documentation Service continued its work

in information and references, supplying the researcher with the necessary and essential bibliography for the performance of their scientific activity. To this end, it continued handling the acquisition of bibliography, and made a good start at distribution, the real reason for being the Documentation Center. This distribution took three paths:

- Distribution of primary documents by reprographics, direct consultation or lending;
- Preparation of secondary documents: the Bulletin of Review Indices, Bulletin of Books and Monographs, and Bulletin of DOE Microfilms.
- Selective Distribution of Information (SDI).

This same year the transfer of 60,000 documents to CIEMAT facilities in CEDER (Soria) was completed. Previously, this documentation was analyzed, selected, cataloged and inventoried. Additionally, a visit was made to CEDER to organize the storage and archiving of these documents and to examine the conditions of the facilities for their conservation. This process of storage in CEDER-Soria continues to be available for future relocations.

Once the reloaction of these CIEMAT documents in CEDER at Soria was completed, a Data Base called the Soria Inventory was created which contains 2 records with bibliographical information on 7,477 technical notices and 776 review titles. The recovery of these documents can be performed using photocopies within a mean time of 2-3 days or, if necessary, almost immediately via Fax (39 requests in 1991).

The CIEMAT Bibliographical Data Base (BDBCIEMAT) has been increased to 1,118 entries. Of these documents 804 are technical notices and 310 are monographs. All of the technical notices result from the interchange of european, asiatic, and american research centers, whose range of work is relted to the energy, environmental and technological work performed at CIEMAT. The 804 technical notices are distributed

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in the following libraries

Main Library	478
Fusion	326

The 310 books received are found in the following Libraries:

Main Library	43
Basic research	54
Renewable Energy	52
Environment	117
Technology Director	26
Nuclear Technology	18

During 1991 the provision of teleaccess to large international databases was continued, particularly those supplied by DIALOG and ESA/IRS for bibliographic searches. In concrete terms, some 507 searches were performed, that is, almost a 20% increase with respect to 1990. Also the direct access to the Arttel system of the British Library was continued, to obtain documents not available in Spain.

Some 263 requests were made, an increase of more than 10% relative to the previous year. Additionally the SDI service continues for the reason that it is useful to the researcher, providing rapid follow-up of subjects of interest.

Simultaneously the documentation and subsequent automation of the CASEN database was begun, with funds provided by the Nuclear Safety Evaluation Commission (CASN); this information is located in the Main Library. Access to these documents is restricted.

This year the Documentation Service managed and operated the Mailing Data Base whose entries consist of the addressees for releases concerning CIEMAT activities such as Press Bulletins, memos, agenda and calendar.

The cooperation in the area of energy documentation acquired by CIEMAT as the Spanish representative to the International Atomic Energy Agency has resulted in sending to the IAEA 35 entries for inclusion in the INIS database, and to the US DOE 35 entries for inclusion in its database.

**PRODUCTION IN 1991**  
**INDICATORS RELATING TO DOCUMENTATION**

- Books and Notices acquired in 1991 . . . . .	1,114
-Total books . . . . .	36,108
- DOE Technical Notices acquired in 1991 . . . . .	14,400
-Total DOE documents . . . . .	646,390
- New entries in BDBCIEMAT, 1991 . . . . .	1,118
-Total entries in BDBCIEMAT . . . . .	4,152
- Conversion of CIEMAT library and creation of CEDER depository. Analysis of 60,000 documents selection, inventory, cataloguing, transport, storage, archiving, computerization, creation and maintenance of Soria Database	
-Technical Notices . . . . .	7,477
-Review Titles . . . . .	776
- Management and control of Reviews, titles . . . . .	869
- Bibliographic searches in International Databases . . . . .	540
- Location and acquisition of technical in- formation in publications not available in Spain. . . . .	263
- Production of Bibliographical Bulletins	
- Book and Monograph Bulletins . . . . .	12
- Review Index Bulletins . . . . .	24
- DOE Bulletin . . . . .	54

**PUBLIC RELATIONS**

## PUBLIC RELATIONS

The Public Relations Section of CIEMAT has actively participated in the organization and presentation of different activities which have taken place at the Center, as well as collaborating in the preparation of shows and congresses within the outreach program.

The different activities presented during 1991 can be summarized in the following sections.

### VISITS TO INSTRUCTIONAL CENTERS

There were 78 group visits to the installations of our Center, groups of students from Institutes offering Bachelor's degrees and Professional Training, with a total of 2028 visitors. This type of visit contributes to the awareness of the scientific activities of CIEMAT in such an important group, young people.

### TECHNICAL VISITS

During 1991 a total of 14 technical visits took place for 214 professionals and persons from different bodies, public as well as private.

We mention particularly the following

- Faculty of Pharmacy-Microbiology (25-2-91)
- INTESA-IMAGE, S.A. (19-4-91)
- Doctors of Chemical Sciences, U.C.M. (5-6-91)
- "Meseta" Cultural Center (14-6-91)
- State Attornies (27-6-91)
- Alcorcon Industrial Arts School (11-7-91)
- AENOR(10-10-91)
- Army College NBQ (17-10-91)

### CONGRESSES AND SEMINARS

The total number of presentations was 58, of which we list the following

- Course of Radiological Protection in Gammagraphy (7/9-I-91)
- Course for Operators of Radioactive Facilities (14/18-I-91)
- Advanced Course on Radiological Protection (15-I to 16-4-91)

- Course on Radiological Protection (Students from Guardia Civil) (4 to 8-2-91)
- Course on Energy-Environment Management in Industry (11 to 15-2-91)
- Course on Measuring Environmental Chemical Pollution: Chromatography and similar techniques (4 to 8-3-91)
- STEP-PROJECT TOMHID working days (8 and 9-4-91)
- Fluidized bed Combustion Course (8 to 10-4-91)
- PASSYS work days (15 to 18-4-91)
- Course for Operators of Radiodiagnostic Facilities (22 to 26-4-91)
- OIEA Course (27-4 to 22-5-91)
- Course on Industrial Chemical Hazards (3 to 19-6-91)
- Course on Thermal Power Stations (Inputs) (10 to 12-6-91)
- Course on Gene transferr in Higher Organisms (24/28-6-91)
- Course on Environmental Chemiometry (23 to 27-9-91)
- Course on Measuring Environmental Radioactivity (21/31-10-91)
- Seminar on Genetic Change and Phenotypes in Chemical Carcinogenesis of the Skin (21-10-91)
- Course on Alpha Spectrometry (Low level measurements) (4 to 7-11-91)
- Course on Handling Solid Urban Wastes (11 to 14-11-91)
- Advanced Course on Industrial Health (Absenteeism)(11 to 15-11-91)
- Course for Police and Guardia Civil Supervisors (11 to 15-11-91)
- Course on Treating Livestock Wastes (21 to 29-11-91)
- Course on Fundamentals, Specifications and Applications of Solar Photovoltaic Energy (10 to 19-12-91)

#### SCIENTIFIC MEETINGS

317 scientific meetings were held with a total of 5,276 attending. Based on Offices and Institutes, these were the results:

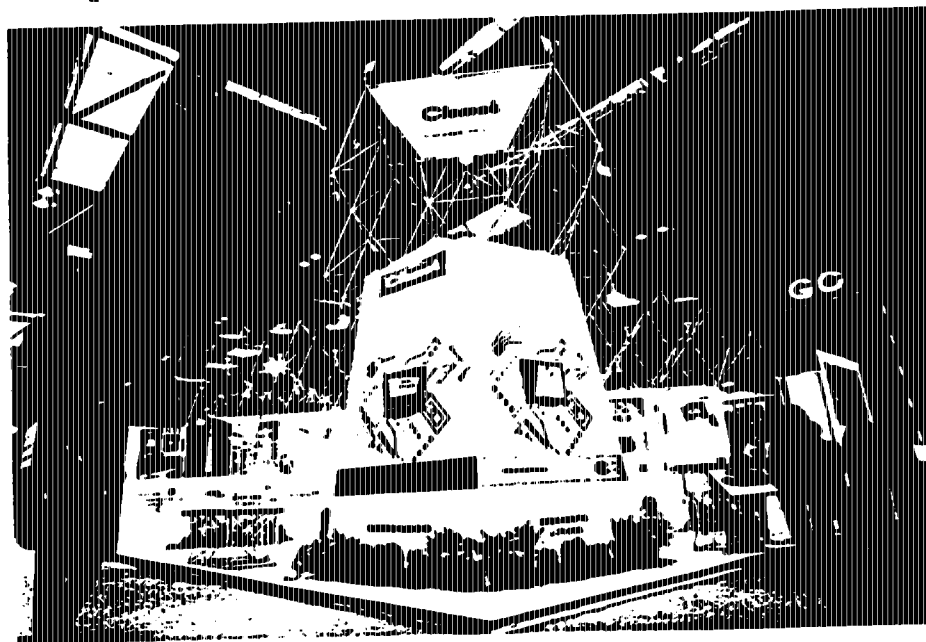


	MEETINGS	ATTENDANCE
General Technical Secretary	42	625
Director of Administration and Finances	2	30
Director of Technology	73	900
Director of Personnel and Organization	36	493
Institute of Energy Studies	51	1,414
Institute of Nuclear Technology	45	733
Institute of the Environment	19	250
Institute of Basic Research	5	130
Institute of Renewable Energy	9	79
Purchasing Department	30	579
Health and Safety Committee	5	52
<b>Totals</b>	<b>317</b>	<b>5,276</b>

In parallel and for the same reason 260 working lunches were held, with 2,855 attending.

#### EXPOSITIONS

The Public Relations Section also carries out the mounting, decoration and dismounting of the CIEMAT stands in fairs and expositions it participates in.



CIEMAT stand at TECHNOVA 91.

In the current year it participated in:

- TECHNOVA 91, held in Madrid from 8 to 11 May
- MIGRATION 91 held in Jerez la Frontera from 21 to 25 Oct., to organize the international congress of the same name

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#### SCHOOL COMPOSITION CONTEST

At the beginning of the school year 1990-91 the Rules for the IV CIEMAT Composition Contest were distributed to the teaching institutions visiting us.

From among the numerous works received, seven went to the finals, of which three were chosen, the prizes being awarded as follows:

1. To the students of the third class of BUP of the Colegio Pureza de Maria, of Madrid, for work on Solar Energy.
2. To the students of the Colegio Bernadette de Aravaca, Madrid, for work titled "How the environment affects Industry"
3. To IB Ramos del Manzano, of Vitigudino, Salamanca, for the work "Renewable Energy - Renew or Die"



The rules for the "V CIEMAT Composition Contest" have



been approved for the school year 1991-92, with the collaboration of the Banco Exterior de Espana, the following prizes having been set:

1. Commemorative Plaque and 125,000 PTA
2. Commemorative Plaque and 75,000 PTA
3. Commemorative plaque and 30,000 PTA

These rules have been sent to all teaching institutions requesting a visit to CIEMAT.

OTHER ACTIVITIES

**OTHER ACTIVITIES****SOCIAL ACTION**

Grants were given to 457 employees and their children to facilitate their studies, amounting to a total of 9.99 Million Pta., and 37 short and 22 medium or long term loans were granted for a total of 13 million pesetas.

**CULTURAL RECREATION GROUP**

The Group has continued its activities, among which merit mention:

**Sports**

CIEMAT teams have continued their participation in football (soccer), basketball and bowling, and social tournaments in tennis, and indoor football and have been organized, and tennis and gymnastics classes are still on offer.



Gymnastics class given at the sport center.

#### Excursions

Four excursions were organized, a total of 200 participating.

#### Residencies

Leases were taken on 51 apartments in different vacation areas and were used by 191 workers and their families

#### Socio-cultural activities

- Fiesta of the Three Kings in the Palafox Cinema, with gifts for 1,300 children and a current children's film shown.
- Affiliate's Day, dedicated to Argentina, in which the folklore and food of the sibling nation are presented together with sport and a happy day of siblinghood with the highest attendance of workers and their families.
- Literature and drawing contest.
- Summer camps for workers' children.

## **ACRONYMS AND SYMBOLS USED**

AB	BILBAO CITY COUNCIL
ABENGOA	ABENGOA S.A.
AC	CARTAGENA CITY COUNCIL
ACAMARMA	CAMARMA CITY COUNCIL
ADESA	ASSOCIATION FOR THE DEVELOPMENT OF SOLAR ENERGY AND ALTERNATIVES IN ANDALUCIA
AECB	ATOMIC ENERGY CONTROL BOARD (CANADA)
AECL	ATOMIC ENERGY OF CANADA LTD.
AENOR	SPANISH STANDARDS AND CERTIFICATION ASSN.
AICIA	ASSOCIATION FOR INDUSTRIAL RESEARCH AND COOPERATION, ANDALUCIA
AIE	INTERNATIONAL ENERGY AGENCY
AIN	NAVARRA INDUSTRY ASSOCIATION
ALMADEN	ALMADEN AND ARRAYANES MINES, S.A.
AM	MADRID CITY COUNCIL
AMYS	ASSOCIATION OF INDUSTRIAL MEDICINE AND SAFETY
ANAIL	ASCO NUCLEAR ASSOCIATION
ANDRA	NATIONAL RADIOACTIVE WASTE AGENCY (FRANCE)
ANDROMACO	ANDROMACO LABORATORIES, S.A.
AP	PAJARA CITY COUNCIL (FUERTEVENTURA)
ARIES	ARIES INDUSTRIAL AND NAVAL, S.A.
ARMINES	ARMINES ENERGY CENTER (FRANCE)
ASCAF	ASSOCIATION FOR DEVELOPMENT OF FUEL FROM FERMENTATION (FR.)
ASINEL	ASSOCIATION FOR INDUSTRIAL ELECTRICITY RESEARCH
ASTAFERSA	FERROL SHOPS AND SHIPYARDS, S.A.
ATERSA	TECHNICAL ENERGY APPLICATIONS, S.A.
BABCOCK	BABCOCK-WILCOX OF SPAIN
BBRI	BELGIAN BUILDING RESEARCH INSTITUTE
BCMNI	EC CENTRAL BUREAU OF NUCLEAR MEASUREMENTS (GEEL, BEL.)
BEL	BELGIUM
BELGOPROCES	BELGOPROCESS (BELGIUM)
BERTIN	BERTIN ET CIE. (FRANCE)
BESEL	BESEL, S.A.
BGS	BRITISH GEOLOGICAL SURVEY
BIOTEC	A. BIOTEC (ITALY)

BP	BP SOLAR OF SPAIN	
BRUNHILDE	BRUNHILDE WORKS GmbH (GFR)	
BSRAE	BRITISH SOCIETY FOR RESEARCH IN AGRICULTURE AND ENGINEERING	/220
CAAM	ALICANTE AND MURCIA SAVINGS SOCIETY	
CABAG	WATER SUPPLY CONSORTIUM, FUERTEVENTURA	
CACCM	MADRID COUNCIL FOR AGRICULTURE AND COOPERATION	
CAM	AUTONOMOUS COMMUNITY OF MADRID	
CARCESA	MEATS AND PRESERVES OF SPAIN, S.A.	
CARNOT	CARNOT, S.A.	
CASA	AEROSPACE CONSTRUCTION, S.A.	
CCA	COMMUNE OF THE CANARIES	
CCAA	AUTONOMOUS COMMUNITIES	
CCHN	JOINT HISPANO-NORTHAMERICAN COMMITTEE	
CCI(JRC)	EC JOINT RESEARCH CENTER	
CCL	COMMUNE OF CASTILLE AND LEON	
CCM	COMMUNE OF CASTILLE-LA MANCHA	
CDER	CENTER FOR DEVELOPMENT OF RENEWABLE ENERGY (MORROCO)	
CDTI	CENTER FOR THE DEVELOPMENT OF INDUSTRIAL TECHNOLOGY	
CE	EUROPEAN COMMUNITY	
CEA	COMMISSION FOR ATOMIC ENERGY (FRANCE)	
CEBAS	CENTER FOR EDAPHOLOGY AND APPLIED SAFETY BIOLOGY	
CECM	COUNCIL FOR EDUCATION, COMMUNITY OF MADRID	
CECUA	CUADRILLERO CERAMICS	
CEDEX	CENTER FOR STUDY AND EXPERIMENTATION, MINISTRY OF PUBLIC WORKS	
CEE	EUROPEAN ECONOMIC COMMUNITY	
CENER	CENTER OF ENERGY STUDIES	
CEI	INTERNATIONAL ELECTROTECHNICAL COMMITTEE	
CEIT	CENTER OF STUDIES AND RESEARCH, GUIPUZCOA	
CENEMESA	NATIONAL ELECTRIC MACHINERY WORKS, S.A.	
CENERG	ENERGY CENTER, PARIS SCHOOL OF MINES	
CENIM	NATIONAL CENTER FOR METALLURGICAL RESEARCH	
CERMAV	CENTER FOR RESEARCH IN VEGETABLE MACROMOLECULES (FRANCE)	
CERN	EUROPEAN PARTICAL PHYSICS LABORATORY (SWITZERLAND)	
CF	CHRONAR FRANCE (LENS, FRANCE)	



CFTJA	COUNCIL FOR DEVELOPMENT AND LABOR, ANDALUCIA	
CIAT	CENTER FOR INSPECTION AND TECHNICAL ASSISTANCE, S.A.	
CICYT	INTERMINISTERIAL COMMISSION ON SCIENCE AND TECHNOLOGY	
CIJI	JUSTESA IMAGEN RESEARCH CENTER, S.A.	
CM	COMMUNITY OF MADRID	
CMSAH	MUNICIPAL HEALTH CENTER OF ALCALA DE HENARES	
CNAL	ALMARAZ NUCLEAR POWER STATION	
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CNR	NATIONAL RESEARCH COUNCIL (ITALY)	
CNRI	NATIONAL RESEARCH COUNCIL (FRANCE)	
CNRS	NATIONAL SCIENTIFIC RESEARCH CENTER (FRANCE)	
CNTR	TRILLO NUCLEAR POWER STATION	
CNVL	VALDECABELLERS NUCLEAR POWER STATION	
COMHURHEX	SOCIETY FOR CONVERSION OF URANIUM METAL AND HEXAFLUORIDE (FR.)	
CONPHOBUS	SOCIETY FOR RESEARCH IN RENEWABLE ENERGY AND ENERGY CONSERVATION (ITALY)	
CRES	CENTER FOR RENEWABLE ENERGY SOURCES (GREECE)	
CSCAE	HIGH COUNCIL OF COLLEGE OF ARCHITECTS (SPAIN)	
CSCAM	MADRID COUNCIL FOR HEALTH AND CONSUMER AFFAIRS	
CSI	HIGH COUNCIL FOR COMPUTING	
CSIC	HIGH COUNCIL FOR SCIENTIFIC RESEARCH	
CSUCICM	HIGH COUNCIL FOR SCIENTIFIC RESEARCH, INSTITUTE OF MATERIALS SCIENCE	
CSN	COUNCIL FOR NUCLEAR SAFETY	
CSTB	CENTER FOR BUILDING SCIENCE AND TECHNOLOGY (FRANCE)	
DASSAULT	AVIONS MARCEL DASSAULT (FRANCE)	
DB	DEPUTATION OF BARCELONA	
DEOGE	DIRECTOR OF INSTRUCTION, ARMY GENERAL STAFF	
DENIM	DEPARTMENT OF NUCLEAR ENERGY, POLYTECHNIC UNIVERSITY, MADRID	
DFVLR	GERMAN RESEARCH INSTITUTE FOR SPACE FLIGHT	
	[German incorrect here, hence two entries]	
DLR	GERMAN RESEARCH INSTITUTE FOR SPACE FLIGHT	
DG	GENERAL DIRECTOR	
DGA	GENERAL DEPUTATION OF ARAGON	
DGAM	GENERAL DIRECTOR OF AMRAMENT AND MATERIAL	

DGE	GENERAL DIRECTOR OF ENERGY
DGICYT	GENERAL DIRECTOR OF SCIENTIFIC AND TECHNICAL RESEARCH
DGIT	GENERAL DIRECTOR OF THE ENVIRONMENT
DGMA	GENERAL DIRECTOR OF CIVIL DEFENCE
DEPT	GENERAL DIRECTOR OF TECHNOLOGY POLICY
DGSP	GENERAL DIRECTOR OF PUBLIC HEALTH
DIC	DIRECTOR OF NAVAL MILITARY CONSTRUCTION
DIN	DENMARK
DOEUSA	DEPARTMENT OF ENERGY (U.S.A.)
DT	DIRECTOR OF TECHNOLOGY
DURO	DURO-FELGURA METALLURGICAL SOCIETY
ECN	NETHERLANDS ENERGY RESEARCH FOUNDATION
ECOTECNIA	ECOTECNIC COOPERATIVE SOCIETY, LTD.
EEIG	EUROPEAN AGENCY FOR RENEWABLE ENERGY
EFTA	EUROPEAN FREE TRADE ASSOCIATION
EHN	NAVARRA HYDROELECTRIC
EINDHOVEN	EINDHOVEN UNIVERSITY OF TECHNOLOGY (HOLLAND)
EISA	INDUSTRIAL EXPERIMENT, S.A.
EMP	ECOLE SUPERIEURE DE MINES, PARIS
EMPRAGRUP	CONSOLIDATED INDUSTRIES, S.A.
ENADIMSA	ADARO NATIONAL MINERAL RESEARCH CO. S.A.
ENAGAS	NATIONAL GAS
ENDESA	NATIONAL ELECTRIC, S.A.
ENEA	NATIONAL BODY FOR ATOMIC POWER (ITALY)
ENEL	NATIONAL BODY FOR ELECTRIC ENERGY (ITALY)
ENFERSA	NATIONAL FERTILIZER INDUSTRIES, S.A.
ENS	NATIONAL SCHOOL OF HEALTH
ENSA	NUCLEAR EQUIPMENT, S.A.
ENSAIA	ENSAIA POLYTECHNIC INSTITUTE OF LORRAINE, FRANCE
ENUSA	NATIONAL URANIUM INDUSTRY, S.A.
EPRI	ELECTRICAL POWER RESEARCH INSTITUTE (U.S.A.)
ERCROS	RIOTINTO AND CROS EXPLOSIVES GROUP
ESA	EUROPEAN SPACE AGENCY (PARIS)
ESADE	HIGH SCHOOL OF INDUSTRIAL ADMINISTRATION AND MANAGEMENT

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ESSA	EQUIPMENT AND SYSTEMS, S.A.	
ETHZ	SWISS FEDERAL TECHNOLOGY INSTITUTE, ZURICH	
ETSIAG	TECHNICAL HIGH SCHOOL FOR AGRONOMY ENGINEERS	
ETSIAR	TECHNICAL HIGH SCHOOL FOR AERONAUTIC ENGINEERS	
ETSII	TECHNICAL HIGH SCHOOL FOR INDUSTRIAL ENGINEERS	
ETSIM	TECHNICAL HIGH SCHOOL FOR MINING ENGINEERS	
ETSIT	TECHNICAL HIGH SCHOOL FOR TELECOMMUNICATIONS ENGINEERS	
EU	UNIVERSITY SCHOOL	
EUITT	UNIVERSITY SCHOOL FOR TELECOMMUNICATIONS TECHNICAL ENGINEERS	
EURATOM	EUROPEAN COMMUNITY ATOMIC ENERGY ASSN.	
	EUROCHEMIC (FRENCH NUCLEAR FUEL REPROCESSING)	/223
EVE	BASQUE ENERGY AUTHORITY	
FBG	BOSCH GIMPERA FOUNDATION, UNIVERSITY OF BARCELONA	
FCM	FORESCAL OF CASTILLA-LA MANCHA S.A.	
FDE	CATALAN ELECTRIC CO.	
FEMPUCM	UNIVERSITY-INDUSTRY FOUNDATION, UNIVERSITY OF COMPLUTENSE	
FEUG	UNIVERSITY OF GALICIA INDUSTRY FOUNDATION	
EGP	GOMEZ PARDO FOUNDATION	
EGUPM	GENERAL FOUNDATION, POLYTECHNIC UNIVERSITY OF MADRID	
FIN	FINLAND	
FISSS	SOCIAL SECURITY HEALTH INVESTIGATION UNIT	
FMI	FINNISH METEOROLOGICAL INVESTIGATION UNIT	
FORESCAL	FORESCAL CASTILLA-LA MANCHA	
FR	FRANCE	
FRA	RAYMOND ARCES FOUNDATION	
FTQS	TORRES QUEVEDO FOUNDATION, UNIVERSITY OF CANTABRIA	
FUNDESCO	FOUNDATION FOR DEVELOPMENT OF THE SOCIAL FUNCTIONS OF TELECOMMUNICATIONS	
GC	SECRETARY GENERAL OF CATALONIA	
GE	GENERAL ELECTRIC CO.	
GEGC	GENERAL CABLE GROUP, SPAIN	
GEOCISA	GEOTECHNICS AND CEMENT, S.A.	
GESTENGA	ENERGY MANAGEMENT OF GALICIA	
G&H	GARRAD AND HASSAN AND PARTNERS (U.K.)	

GR GREECE  
 GRAINVAL GIE GRAINVAL (FRANCE)  
 GSF GSF, MUNICH  
 GV GENERAL SECRETARY OF VALENCIA  
 HIDROLA HYDROELECTRIC OF SPAIN, S.A.  
 HIFRENSA HISPANO-FRENCH NUCLEAR ENERGY, S.A.  
 HOL HOLLAND  
 HOSCLISC HOSPITAL CLINIC OF SAN CARLOS  
 HOSRACAJ RAMON AND CAJAL HOSPITAL  
 HUNOSA NORTHEASTERN COLLIERIES, S.A.  
 IBM  
 ICCSIC INSTITUTE OF CATALYSIS AND PETROCHEMICALS OF THE HIGH COUNCIL  
 FOR SCIENTIFIC RESEARCH  
 ICRM INTERNATIONAL COMMITTEE OF RADIOISOTOPE NUCLIDE RESEARCH  
 ICSTAM THE IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE, U.K.  
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 IDAE INSTITUTE OF ENERGY DIVERSIFICATION AND CONSERVATION  
 IDEA FOODSTUFF RESEARCH AND DEVELOPMENT, S.A.  
 IDEMSA MEDICAL EQUIPMENT RESEARCH AND DEVELOPMENT, S.A.  
 IEC INSTITUTE OF CATALAN STUDIES  
 IEE INSTITUTE OF ENERGY STUDIES  
 IEO SPANISH INSTITUTE OF OCEANOGRAPHY  
 IER INSTITUTE OF RENEWABLE ENERGY  
 IES MADRID POLYTECHNIC UNIVERSITY INSTITUTE OF SOLAR ENERGY  
 IFAC TECHNICAL INSTITUTE OF THE ACADEMY OF SCIENCES (RUSSIA)  
 IFE INSTITUTE FOR ENERGY TECHNOLOGY, NORWAY  
 IB INSTITUTE OF BASIC RESEARCH  
 IMA INSTITUTE OF THE ENVIRONMENT  
 IMFYE FOREST WOOD AND ENERGY ENGINEERING  
 IMEC IMEC V.Z.W., LOUVAIN, BEL.  
 INASMET BASQUE ASSOCIATION FOR METALLURGY  
 INCAPSA HEAT EXCHANGERS, S.A.  
 ENEM NATIONAL EMPLOYMENT INSTITUTE  
 INFE NATIONAL INSTITUTE OF DEVELOPMENT AND EXPORT  
 INFM INFM, MUNICH

INI	NATIONAL INDUSTRY INSTITUTE
INIA	NATIONAL AGRICULTURE RESEARSH INSTITUTE
INITEC	NATIONAL ENGINEERING AND TECHNOLOGY CO. S.A.
INM	NATIONAL METEROLOGICAL INSTITUTE
INMG	NATIONAL METEOROLOGICAL AND GEOPHYSICS INSTITUTE, PORTUGAL
INRA	NATIONAL AGRONOMY RESEARCH INSTITUTE, FRANCE
INSALUD	NATIONAL INSTITUTE OF HEALTH
INSHT	NATIONAL INSTITUTE OF INDUSTRIAL HEALTH AND SAFETY
INTA	NATIONAL INSTITUTE OF AEROSPACE TECHNOLOGY
INTAKTA	INTAKTA FRANCE
INTERA	INTERA ECL, U.K.
INTERATOM	INTERATOM
NYPSA	REPORTS AND PROJECTS, S.A.
IPLAS	INSTITITUTE OF PHYSICS OF THE LITHUANIAN ACADEMY OF SCIENCES
IPP	INSTITUTE OF PLASMA PHYSICS, MAX PLANCK INSTITUTE
IPSN	INSTITUTE FOR NUCLEAR PROTECTION AND SAFETY, FRANCE
IQS	SARRIA CHEMICAL INSTITUTE
IR	IRELAND
ISCIH	CARLOS III HEALTH INSTITUTE
ISET	INSTITUTE FOR SOLAR ENERGY MANAGEMENT (? poor german again) TECHNOLOGY,GERMANY
ISFH	SOLAR ENERGY RESEARCH INSTITUTE, GmbH, GERMANY
ISODER	ISOTOPEs AND DERIVATIVES,S.A.
ISOFOTON	ISOFOTON
ITGME	TECHNOLOGICAL AND MINING INSTITUTE OF SPAIN
IT	ITALY
ITN	NUCLEAR TECHNOLOGY INSTITUTE
IVIA	VALENCIAN AGRICULTURE RESEARCH INSTITUTE
IW	MATERIALS SCIENCE INSTITUTE, HANNOVER
JA	GOVERNMENT OF ANDALUCIA
JCYL	GOVERNMENT OF CASTILLE AND LEON
JEMA	JESUS MARIA AGUIRRE, S.A.
JRC(OC)	JOINT RESEARCH CENTRE, E.C.
JUSTE	JUSTE LABORATORIES, S.A., PHARMACEUTICAL CHEMICALS

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KEMAKTA KEMAKTA CONSULTING AB, SWEDEN  
 KEK ATOMIC RESEARCH CENTER, GERMANY  
 KUL CATHOLIC UNIVERSITY OF LOUVAIN, GERMANY  
 KWS KELINWANZLEBENER SAATZUCHT AG, GERMANY  
 KWU POWER GENERATING UNION, GERMANY  
 LAINSA INDUSTRIAL CLEANLINESS AND PACKING, S.A.  
 LANL LOS ALAMOS NATIONAL LABORATORY  
 LNETI NATIONAL LABORATORY OF ENGINEERING AND TECHNOLOGY, PORTUGAL  
 LPRI BASIC IONIZING RADIATION LABORATORY, FRANCE  
 MADE AUXILIARY ELECTRIFICATION EQUIPMENT, S.A.  
 MAN M.A.N. TECHNOLOGY GmbH, GERMANY  
 MAP MINISTRY FOR PUBLIC RELATIONS  
 MAREA EFFICIENCY AND ENVIRONMENTAL RESOURCES, S.A.  
 MASA ALMAGRERA MINES, S.A.  
 MC MINISTRY OF CULTURE  
 MDDGAM MINISTRY OF DEFENSE, DIRECTOR OF ARMAMENTS AND MATERIEL  
 MI MINISTRY OF THE INTERIOR  
 MIE MINISTRY OF INDUSTRY AND ENERGY  
 MIGJORN MIGJORN, S.A.  
 MINER MINISTRY OF INDUSTRY AND ENERGY  
 MIT M.I.T.  
 MITUSA M.I.T.  
 MQMPRESA PRECISION MACHINE INSTALLATION, S.A.  
 MOPU MINISTRY OF URBAN AND PUBLIC WORKS  
 MRC MEDICAL RESEARCH COUNCIL, U.K.  
 MT MINISTRY OF LABOR AND SOCIAL SECURITY  
 MVSI MANUAL VASQUEZ INDUSTRIAL SUPPLIES, S.A.  
 NBSUSA NATIONAL BUREAU OF STANDARDS  
 NDT NDT ENGINEERING  
 NEB NUCLEAR ENERGY BOARD, IRELAND  
 NEWJER NEW JERSEY, S.A.  
 NIPHEP NATIONAL INSTITUTE OF PUBLIC HEALTH AND ENVIRONMENT, HOLLAND  
 NIST NATIONAL INSTITUTE FOR STANDARDS AND TECHNOLOGY, USA  
 NIASR NETHERLANDS ORGANIZATION FOR APPLIED SCIENTIFIC RESEARCH

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NRPB NATIONAL RADIOLOGICAL PROTECTION BOARD, U.K.  
 NUCLEN NUCLEAR POWER NORTH, S.A.  
 NUKEM NUKEM GmbH, GERMANY  
 OCED  
 OCICAR ASSOCIATION FOR RESEARCH AND MANAGEMENT OF COAL TECHNOLOGY  
 DEVELOPMENT  
 OCIDE OFFICE OF ELECTRONICS COOPERATION, RESEARCH AND DEVELOPMENT  
 OIEA INTERNATIONAL ATOMIC ENERGY ASSOCIATION  
 ORGEMERGENERAL MARKETING BOARD  
 ORNLUS OAK RIDGE NATIONAL LABORATORY  
 OTRI OFFICE OF RESEARCH RESULTS COMMUNICATION  
 OTT OFFICE OF TECHNOLOGY TRANSFER  
 PECHIN GROUPE PECHINEY, FRANCE  
 PETSIM PATRON OF THE INDUSTRIAL ENGINEERING TECHNICAL HIGH SCHOOL,  
 MADRID  
 PEUI UNESA-INI ENERGY PROGRAM  
 PHYSIKA PHYSICAL-TECHNICAL OFFICE, GERMANY  
 PTEPMA PLAN FOR WOOD PRODUCTS ENERGY RESEARCH  
 PM PABLO MORENO, S.A.  
 PNUMA U.N. ENVIRONMENTAL PROGRAM  
 POR PORTUGAL  
 PRESUR INTEGRATED CONCENTRATES OF SOUTHEASTERN SPAIN  
 PROCESA PRIVATE MUNICIPAL SOCIETY FOR SOCIECONOMIC GROWTH, CEUTA  
 PROCITEOFFICE OF ENGINEERING SCIENCE AND TECHNOLOGY, BARCELONA  
 REGIS ST. REGIS PAPER, U.K.  
 RELE SPANISH TESTING LABORATORIES NETWORK  
 RHONE RHONE-POULENC FARMA, S.A.  
 RNL RISO NATIONAL LABORATORY, DENMARK  
 RFA GERMANY  
 RFA RHONE-POULENC SANTE ('HEALTH PRODUCTS'), S.A., FRANCE  
 RP SPANISH ROYAL SOCIETY OF PHYSICS  
 RU U.K.  
 SABSC SEMINAR ON BIOCLIMACTIC ARCHITECTURE OF SEVILLE  
 SAICA ARAGON CELLULOSE INDUSTRIES, S.A.

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SCAP ESCAP EUROPE, S.A.  
 SCK/CEN ATOMIC ENERGY RESEARCH CENTER, BELGIUM  
 SEAC SPANISH CYBERNETICS SOCIETY  
 SEP EUROPEAN PROPULSION SOCIETY  
 SERM SECRETARY OF ENERGY AND MINERAL RESOURCES  
 SERMASA ENERGY SOCIETY, MADRID REGION, S.A.  
 SEVILL SEVILLE ELECTRIC CO. S.A.  
 SGMA GENERAL SECRETARY OF THE ENVIRONMENT  
 SGPB GENERAL SECRETARY OF THE NATIONAL PLAN  
 SGT GENERAL TECHNICAL SECRETARY  
 SINAE INTEGRATED ENERGY CONSERVATION SERVICES  
 SMHA SOUTH MANCHESTER HEALTH AUTHORITY, U.K.  
 SOFRETEC SOFRETEC, S.A. FRANCE  
 SPE STORK PRODUCT ENGINEERING, HOLLAND  
 SRD SAFETY RELIABILITY DIRECTORATE, U.K.  
 SSI STATE RADIATION DOSE INSTITUTE, SWEDEN  
 SSOCT CELLULOSE, PAPER AND TEXTILE FIBRE EXPERIMENTAL CENTER, ITALY  
 STUO SVIK STUO SVIK ENERGY TECHNOLOGY, SWEDEN  
 SUE SWEDEN  
 SUI SECRETARY OF UNIVERSITIES AND RESEARCH  
 SUZ SWITZERLAND  
 SYPER RENEWABLE ENERGY SYSTEMS AND PROJECTS  
 TAAB TEKNIKRUPPEN, AB, SWEDEN  
 TECNATOM TECNATOM, S.A.  
 TECNER TECNERCON, S.A.  
 TECNOL TECHNOLOGY, S.A.  
 TECSA TESCA (ITALY)  
 TERMIA HEAT INDUSTRIES, ANDALUCIA, S.L.  
 THOMSON THOMPSON SPACE AND MILITARY GROUP, S.A. FRANCE  
 TNO NETHERLANDS ORGANIZATION FOR APPLIED SCIENCE RESEARCH  
 TORRES TORRES DANG, S.L.  
 TRANSNUC TRANSNUCLEAR, S.A.  
 TRC TECHNICAL RESEARCH CENTER, FINLAND  
 TRICO TRINITY COLLEGE, DUBLIN  
 TRSA UNITED TUBE, S.A.



TUDK TECHNICAL UNIVERSITY, DENMARK  
 UA UNIVERSITY OF ALICANTE  
 UAB AUTONOMOUS UNIVERSITY OF BARCELONA  
 UAH UNIVERSITY OF ALCALA DE HENARES  
 UAM AUTONOMOUS UNIVERSITY OF MADRID  
 UAP UNIVERSITY OF AVIERO  
 UB UNIVERSITY OF BARCELONA  
 UC UNIVERSITY OF CANTABRIA  
 UCD UNIVERSITY COLLEGE, DUBLIN  
 UCM COMPLUTENSE UNIVERSITY OF MADRID  
 UCMFP COMPLUTENSE UNIVERSITY OF MADRID, PSYCHOLOGY FACULTY  
 UCO UNIVERSITY OF COMILLAS  
 UDELFT UNIVERSITY OF TECHNOLOGY, HOLLAND  
 UEF FENOSA ELECTRICAL UNIOIN  
 UESSEN ESSEN GHS UNIVERSITY  
 UESSEX UNIVERSITY OF ESSEX  
 UEX UNIVERSITY OF EXTREMADURA  
 UGINEBRA UNIVERSITY OF GENEVA  
 UGR UNIVERSITY OF GRANADA  
 UHANN UNIVERSITY OF HANNOVER  
 UIB UNIVERSITY OF THE BALEARIC ISLANDS  
 UTTESA IBEROAMERICAN ELECTRICAL TECHNOLOGY UNIT, S.A.  
 UKAEA UNITED KINGDOM ATOMIC ENERGY AUTHORITY  
 UKRFA UNIVERSITY OF COLOGNE  
 UL UNIVERSITY OF LEON  
 ULANCAS UNIVERSITY OF LANCASTER  
 ULISBO UNIVERSITY OF LISBON  
 UM UNIVERSITY OF MALAGA  
 UMIST UNIVERSITY OF MANCHESTER INSTITUTE OF SCIENCE AND TECHNOLOGY,  
       U.K.  
 UMUNISC MUNICH TECHNICAL INSTITUTE  
 UNANCY UNIVERSITY OF NANCY  
 UNANTES UNIVERSITY OF NANTES  
 UNED NATIONAL UNIVERSITY FOR EDUCATION BY CORRESPONDENCE  
 UNEW UNIVERSITY OF NEWCASTLE

UNESA ELECTRICAL GROUP, S.A.  
 UNJU JUJUY NATIONAL UNIVERSITY, ARGENTINA  
 UO UNIVERSITY OF OVIEDO  
 UPB BARCELONA POLYTECHNIC UNIVERSITY  
 UPC CATALAN POLYTECHNIC UNIVERSITY  
 UPM MADRID POLYTECHNIC UNIVERSITY  
 UPMETSI MADRID POLYTECHNIC UNIVERSITY, TECHNICAL HIGH SCHOOL OF  
 INDUSTRIAL ENGINEERING  
 UPORTO UNIVERSITY OF OPORTO  
 UPV POLYTECHNIC UNIVERSITY OF VALENCIA  
 UPVETSI BASQUE UNIVERSITY, TECHNICAL HIGH SCHOOL OF INDUSTRIAL  
 ENGINEERING  
 UREADING UNIVERSITY OF READING, U.K.  
 UROMA ROME RESEARCH UNIVERSITY  
 US UNIVERSITY OF SEVILLE  
 USAL UNIVERSITY OF SALAMANCA  
 USDOE DEPARTMENT OF ENERGY, USA  
 USETSII SEVILLE UNIVERSITY TECHNICAL HIGH SCHOOL OF INDUSTRIAL  
 ENGINEERING  
 USHEFF UNIVERSITY OF SHEFFIELD  
 USTUTT UNIVERSITY OF STUTTGART  
 UTOR UNIVERSITY OF TURIN  
 UTRECH UTRECHT UNIVERSITY  
 UV UNIVERSITY OF VALENCIA  
 UVA UNIVERSITY OF VALLADOLID  
 UZ UNIVERSITY OF ZARAGOZA  
 VACTRON VACTRON, S.A.  
 VELIA CONSORTIUM OF VELIA FOR IMPROVING THE ENVIRONMENT, ITALY  
 VINSNA NAVARRE HOUSING DEPARTMENT  
 VIRLAB VIRLAB, S.A.  
 WENESA WESTINGHOUSE NUCLEAR OF SPAIN, S.A.  
 WESINTER WESTINGHOUSE INTERNATIONAL, USA  
 ZELLPLAN THE PLANNING COMPANY

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